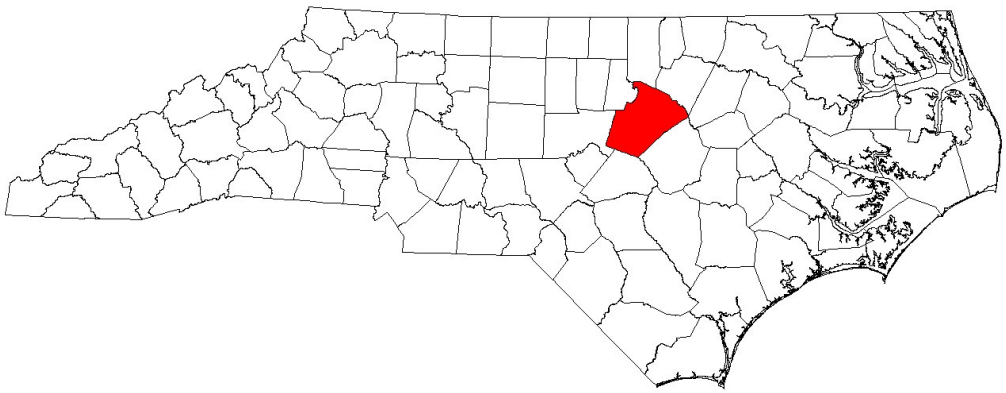
ANNUAL REPORT FOR 2004



Marks Creek Stream Mitigation Site
Wake County
WBS Element 34455.4.2
TIP No. R-2547WM

Prepared By:
Office of Natural Environment & Roadside Environmental Unit
North Carolina Department of Transportation
March 2005

Summary

The following report summarizes the stream monitoring activities that have occurred during the Year 2004 at the Marks Creek Site in Wake County. This site was designed and constructed during 2002 by North Carolina Department of Transportation (NCDOT). This report provides the monitoring results for the first formal year of monitoring (Year 2004). Monitoring will continue at this site for another four years or until all success criteria are satisfied. The Marks Creek Site will be monitored again in 2005.

Based on the overall conclusions of monitoring along the Main Tributary to Marks Creek, the North Tributary, the West Tributary, the Southwest Tributary, and the South Tributary, the Site has met the required monitoring protocols for the first year of monitoring. Localized areas of active bank scour and erosion exist; however, immediate stabilization is not required at this time.

Based on information obtained from the USGS, the Marks Creek Site has met the required hydrologic monitoring protocols of two bankfull events. No biological sampling has been conducted to-date. It is unknown whether or not this sampling will be conducted as part of overall monitoring activities.

1.0 INTRODUCTION

1.1 Project Description

The following report summarizes the stream monitoring activities that have occurred during the Year 2004 at the Marks Creek Site. The site is situated immediately adjacent to the right-of-way of the future Knightdale Bypass in the eastern portion of Wake County (Figure 1). It is located approximately 8.0 miles (12.9 kilometers) east of Raleigh. The Marks Creek Site was constructed to provide mitigation for stream impacts associated with the Knightdale Bypass Transportation Improvement Program (TIP) number R-2547/R-2641 in Wake County.

The stream mitigation project involved the restoration of an unnamed tributary to Marks Creek (the Main Tributary to Marks Creek) and four of its tributaries (the North, West, Southwest, and South Tributaries). As part of the project, NCDOT drained an approximately 10-acre pond and removed the dam in its entirety. In addition, new channels were constructed as near as practicable to their former locations before initial dam construction was implemented. The reconnection of the Main Tributary to Marks Creek and its tributaries to their original floodplain resulted in the Priority I restoration of approximately 3,200 linear feet. Design and construction was implemented during 2002 by NCDOT. Stream restoration involved the construction of new channels and the installation of rootwads, rock vanes, rock cross vanes, log vanes to control grade and stabilize the channel. It also included the installation of native vegetation.

1.2 Purpose

According to the mitigation plan (NCDOT, 2001), the objectives for this mitigation site were to improve water and riparian quality as well as stability associated with the Main Tributary to Marks Creek and its unnamed tributaries.

Successful stream mitigation is demonstrated by a stable channel that does not aggrade or degrade over time. It is also demonstrated by reduced erosion rates, the permanent establishment of native vegetation, and bed features consistent with the design stream type. Results of stream monitoring conducted during the 2004 growing season at the Marks Creek Site are included in this report.

Activities in 2004 reflect the first formal year of monitoring following the restoration efforts; however, it is the second year since construction. Included in this report are analyses on stability (primarily the longitudinal profile and cross sections) and site photographs.

1.3 Project History

July to August 2001	Pond Drained.
Late 2002	Restoration Completed.
June 2004	Stream Channel Monitoring (1 yr.)

During 2003, several heavy rain events caused the existing erosion control devices to fail. These devices were part of the construction of the Knightdale Bypass upstream of the

mitigation site. As a result, the site was inundated with sediment which prohibited monitoring during the 2003 growing season. NCDOT decided to conduct the first formal year of monitoring in 2004, once the new erosion control devices had been implemented and the streams had a chance to stabilize.

2.0 STREAM ASSESSMENT

2.1 Success Criteria

The success criteria, as defined by federal guidelines for stream mitigation, includes the following main parameters: no less than two bankfull events for the five-year monitoring period, reference photos, plant survivability analyses, and channel stability analyses (USACE, 2003). Biological sampling was not required for this site.

Natural streams are dynamic systems that are in a constant state of change. Longitudinal profile and cross section surveys will differ from year to year based on changes in the watershed. Natural channel stability is achieved by allowing the stream to develop a proper dimension, pattern, and profile such that, over time, channel features are maintained and the stream system neither aggrades nor degrades. A stable stream consistently transports its sediment load, both in size and type, associated with local deposition and scour. Channel instability occurs when the scouring process leads to degradation, or excessive sediment deposition results in aggradation (Rosgen, 1996). The following surveys were conducted in support of the monitoring assessment:

- Longitudinal Profile Survey. This survey addressed the overall slope of the reach, as well as slopes between bed features. The bed features are secondary delineative criteria describing channel configuration in terms of riffle/pools, rapids, step/pools, cascades and convergence/divergence features which are inferred from channel plan form and gradient. The surveys are compared on a yearly basis to note and/or compare aggradation, degradation, head cuts, and areas of mass wasting. The longitudinal profile is expected to change from year to year. Significant changes may require additional monitoring.

- Cross Section Surveys. These surveys addressed the following characteristics at various locations along the reach: entrenchment ratio, width/depth ratio, and dominant channel materials. The entrenchment ratio is a computed index value used to describe the degree of vertical containment. The width/depth ratio is an index value which indicates the shape of the channel cross section. The dominant channel materials refer to a selected size index value, the D_{50}, representing the most prevalent of one of six channel material types or size categories, as determined from a channel material size distribution index.

2.2 Stream Description

2.2.1 Post-Construction Conditions

The mitigation of the Main Tributary to Marks Creek, the North Tributary, the West Tributary, the South Tributary, and the Southwest Tributary involved the draining of the existing pond and the construction of four new channels on site. Within the new channels, j-hook vanes, rock and log vanes, and rootwad revetments were installed. Unfortunately, soon after restoration, the site it was inundated with sediment from the construction of the Knightdale Bypass located upstream. This inundation was due to the failure of the erosion sediment control devices. Currently, new devices have been implemented; however the excess sediment is still in the process of being expunged from the system.

2.2.2 Monitoring Conditions

The Main Tributary to Marks Creek, the North Tributary, the West Tributary, the South Tributary, and the Southwest Tributary were designed to be classified as C5 stream type channels according to the Rosgen Classification of Natural Rivers; however only the South Tributary classifies as C5, the remaining tributaries classify as a C4 stream type. A total of sixteen cross sections (four along the Main Tributary to Marks Creek and 12 along its four tributaries) were surveyed. For this report, only cross sections containing riffles were used in the comparison of channel morphology presented below in Table 1. Channel stationing is provided on Figure 2.

Table 1. Abbreviated Morphological Summary (Marks Creek Site)

Variable*	North Tributary (Cross Sections #1, #2, and #3)					
	As-Built	2004		2005	2006	2007
		Cross-Section #2	Min - Max			
Drainage Area (mi^2)	0.19	0.19	0.19	0.19	0.19	0.19
Bankfull Width (ft)	13	15.2	7.9 – 15.2			
Bankfull Mean Depth (ft)	0.8	0.5	0.5 - 0.9			
Width/Depth Ratio	17	30.4	15.1 - 30.4			
Bankfull Cross Sectional Area (ft^2)	10	7.6	4.0 – 12.2			
Maximum Bankfull Depth (ft)	1.4	0.9	0.9 – 1.4			
Width of Floodprone Area (ft)	50+	300	300 - 400			
Entrenchment Ratio	3.8	19.7	19.7 – 50.6			
Slope	0.008	-	0.015			
Particle Sizes (Riffle Sections)						
D_{16} (mm)	-	0.5	0.5 – 1.1			
D_{35} (mm)	-	3.67	1.27 – 3.67			
D_{50} (mm)	-	15	2.8 - 15			
D_{84} (mm)	-	21	20 - 24			
D_{95} (mm)	-	27	27 - 29			

Variable*	West Tributary (Cross Sections #5 and #7)						
	As-Built	2004			2005	2006	2007
		Cross-Section #5	Min - Max				
Drainage Area (mi^2)	0.27	0.27	0.27		0.27	0.27	0.27
Bankfull Width (ft)	13	14.1	14.1 – 22.3				
Bankfull Mean Depth (ft)	0.8	0.8	0.6 – 0.8				
Width/Depth Ratio	16	17.6	17.6 – 37.2				
Bankfull Cross Sectional Area (ft^2)	10.5	11.3	11.3 – 13.4				
Maximum Bankfull Depth (ft)	1.5	1.3	1.3 – 1.7				
Width of Floodprone Area (ft)	50+	375	375 - 450				
Entrenchment Ratio	3.8	26.6	20.2 – 26.6				
Slope	0.005	-	0.014				
Particle Sizes (Riffle Sections)							
D_{16} (mm)	-	0.56	0.56 – 0.72				
D_{35} (mm)	-	4.66	1.44 – 4.66				
D_{50} (mm)	-	8.3	8 – 8.3				
D_{84} (mm)	-	16	16 - 22				
D_{95} (mm)	-	20	20 - 41				
	South Tributary (Cross Sections #8 and #11)						
	As-Built	2004			2005	2006	2007
		Cross-Section #8	Min - Max				
Drainage Area (mi^2)	0.15	0.15	0.15		0.15	0.15	0.15
Bankfull Width (ft)	13	10.5	10.5 – 14.7				
Bankfull Mean Depth (ft)	0.7	0.6	0.3 – 0.6				
Width/Depth Ratio	18	17.5	17.5 - 49				
Bankfull Cross Sectional Area (ft^2)	9	6.3	4.4 – 6.3				
Maximum Bankfull Depth (ft)	1.3	1.1	0.8 – 1.1				
Width of Floodprone Area (ft)	50+	75	75 - 150				
Entrenchment Ratio	3.8	7.1	7.1- 10..2				
Slope	0.006	-	0.013				
Particle Sizes (Riffle Sections)							
D_{16} (mm)	-	0.56	<0.062 - 0.56				
D_{35} (mm)	-	0.97	<0.062 - 0.97				
D_{50} (mm)	-	2.4	0.3 – 2.4				
D_{84} (mm)	-	11	1 - 11				
D_{95} (mm)	-	16	1 - 16				

Variable*	Southwest Tributary (Cross Section #12)						
	As-Built**	2004***		2005	2006	2007	
		Cross-Section #12	Min - Max				
Drainage Area (mi^2)	0.15	0.15	0.15	0.15	0.15	0.15	
Bankfull Width (ft)	-	15.9	-				
Bankfull Mean Depth (ft)	-	0.3	-				
Width/Depth Ratio	-	53.0	-				
Bankfull Cross Sectional Area (ft^2)	-	4.8	-				
Maximum Bankfull Depth (ft)	-	0.7	-				
Width of Floodprone Area (ft)**	-	375	-				
Entrenchment Ratio	-	23.6	-				
Slope	-	-	0.013				
Particle Sizes (Riffle Sections)							
D_{16} (mm)	-	0.824	-				
D_{35} (mm)	-	1.77	-				
D_{50} (mm)	-	6	-				
D_{84} (mm)	-	22	-				
D_{95} (mm)	-	28	-				
Variable*	Main Tributary to Marks Creek (Cross Section #15)						
	As-Built	2004***		2005	2006	2007	
		Cross-Section #15	Min - Max				
Drainage Area (mi^2)	0.67	0.67	0.67	0.67	0.67	0.67	
Bankfull Width (ft)	18	17.3	-				
Bankfull Mean Depth (ft)	1.0	0.7	-				
Width/Depth Ratio	17	24.7	-				
Bankfull Cross Sectional Area (ft^2)	10	12.1	-				
Maximum Bankfull Depth (ft)	1.4	1.9	-				
Width of Floodprone Area (ft)	50+	600	-				
Entrenchment Ratio	3.8	34.7	-				
Slope	0.008	-	0.005				
Particle Sizes (Riffle Sections)							
D_{16} (mm)	-	0.099	-				
D_{35} (mm)	-	13.69	-				
D_{50} (mm)	-	19.5	-				
D_{84} (mm)	-	29	-				
D_{95} (mm)	-	32	-				

* Variables without a Min/Max range are averaged values and indicate no range could be referenced.
** No as-built data was available for the Southwest Tributary.
*** Only one riffle section was surveyed within the reach.

2.3 Results of the Stream Assessment

2.3.1 Site Data

The assessment included the survey of sixteen newly established cross sections across the four streams and the longitudinal profile of the four streams. The length of the profile along Marks Creek was approximately 950 linear feet. The profiles associated with the North, West, South, and Southwest Tributaries were approximately 700 linear feet, 550 linear feet, 180 linear feet, and 970 linear feet, respectively. Cross section locations were subsequently based on the stationing of the longitudinal profile and are presented below.

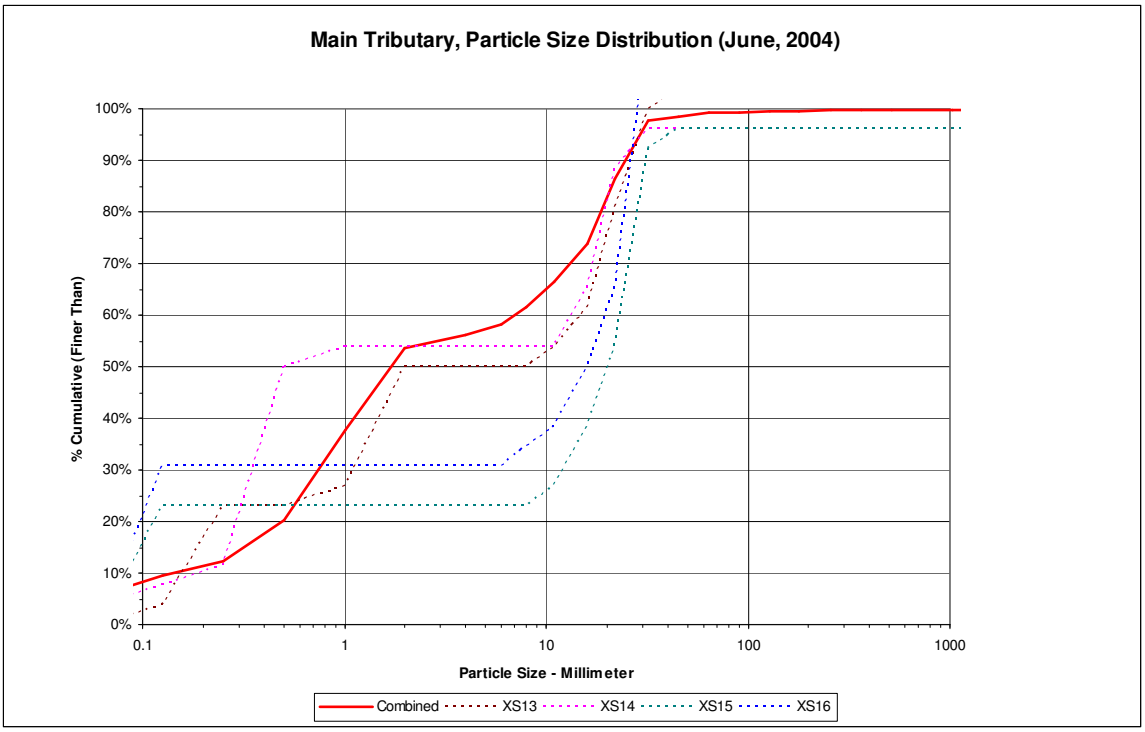
- Cross Section #1. North Tributary, Station 11+46, midpoint of riffle
- Cross Section #2. North Tributary, Station 12+30, head of riffle
- Cross Section #3. North Tributary, Station 14+97, midpoint of riffle
- Cross Section #4. North Tributary, Station 16+68, pool
- Cross Section #5. West Tributary, Station 11+65, midpoint of riffle
- Cross Section #6. West Tributary, Station 12+85, pool
- Cross Section #7. West Tributary, Station 14+61, midpoint of riffle
- Cross Section #8. South Tributary, Station 11+27, midpoint of riffle
- Cross Section #9. South Tributary, Station 14+13, pool
- Cross Section #10. South Tributary, Station 17+44, midpoint of run
- Cross Section #11. South Tributary, Station 18+72, midpoint of riffle
- Cross Section #12. Southwest Tributary, Station 10+29, midpoint of riffle
- Cross Section #13. Main Tributary, Station 10+75, midpoint of run
- Cross Section #14. Main Tributary, Station 14+51, pool
- Cross Section #15. Main Tributary, Station 16+23, midpoint of riffle
- Cross Section #16. Main Tributary, Station 19+30, midpoint of glide

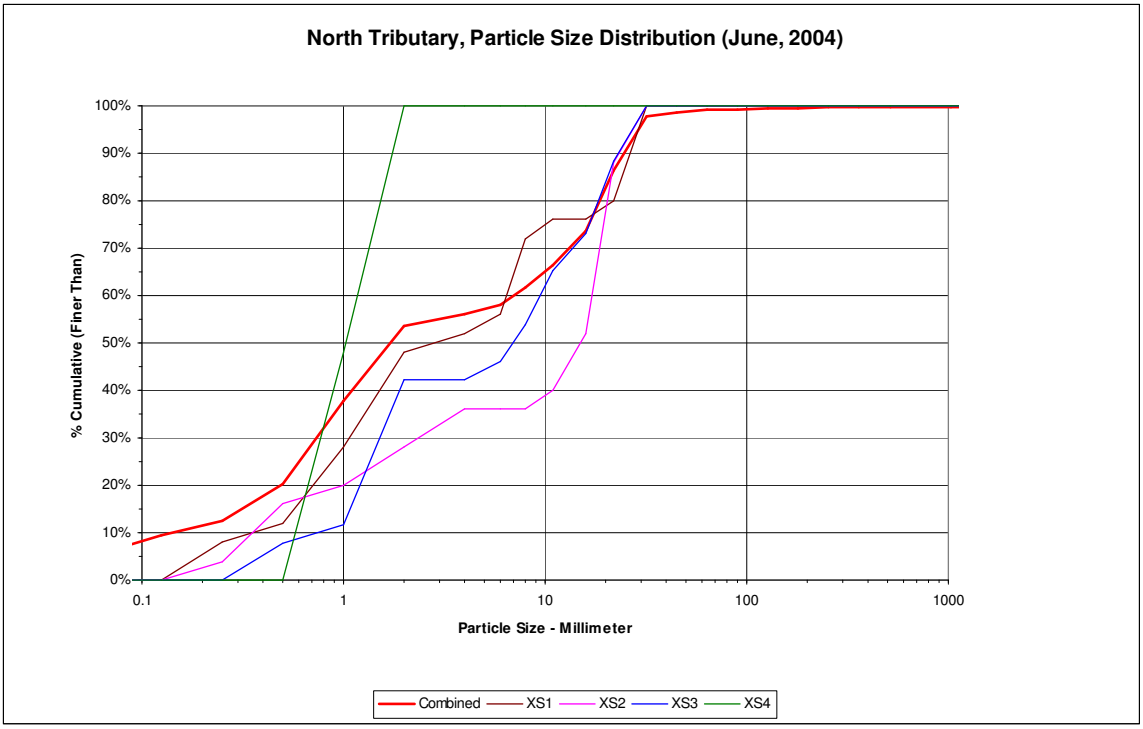
The location of all sixteen cross sections was established during the 2004 monitoring period. No cross sectional surveys were completed prior to 2004 at the Marks Creek site. Therefore, no comparisons can be made to the data collected during 2004. This data will be used for comparison with future survey data. Future survey data will vary depending on actual location of rod placement and alignment; however, this information should remain similar in overall appearance. The cross section graphs are presented in Appendix A.

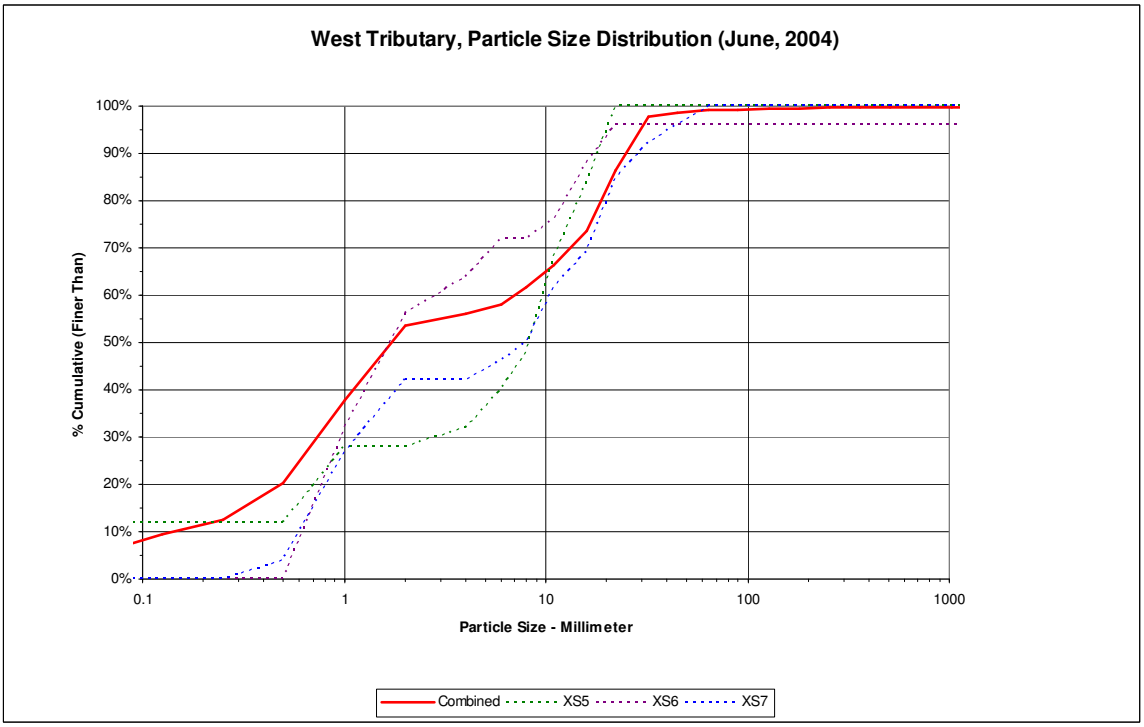
Pebble counts were taken at each cross section as a means of determining the extent of change in bed material over the five year monitoring period. However, only pebble counts taken at riffle sections will be utilized to classify the stream. No existing data was available for the Main Tributary to Marks Creek or its tributaries. The pebble counts taken during the Year 2004 monitoring period noted that the D_{50} (50 percent of the sampled population is equal to or finer than the representative particle diameter) for the riffle sections of the Main Tributary as approximately 19.5 mm. The D_{50} for the North Tributary was approximately 6.9 mm, the D_{50} for the West Tributary was approximately 8.2 mm, the D_{50} for the South Tributary was approximately 0.6 mm, and the D_{50} for the Southwest Tributary was

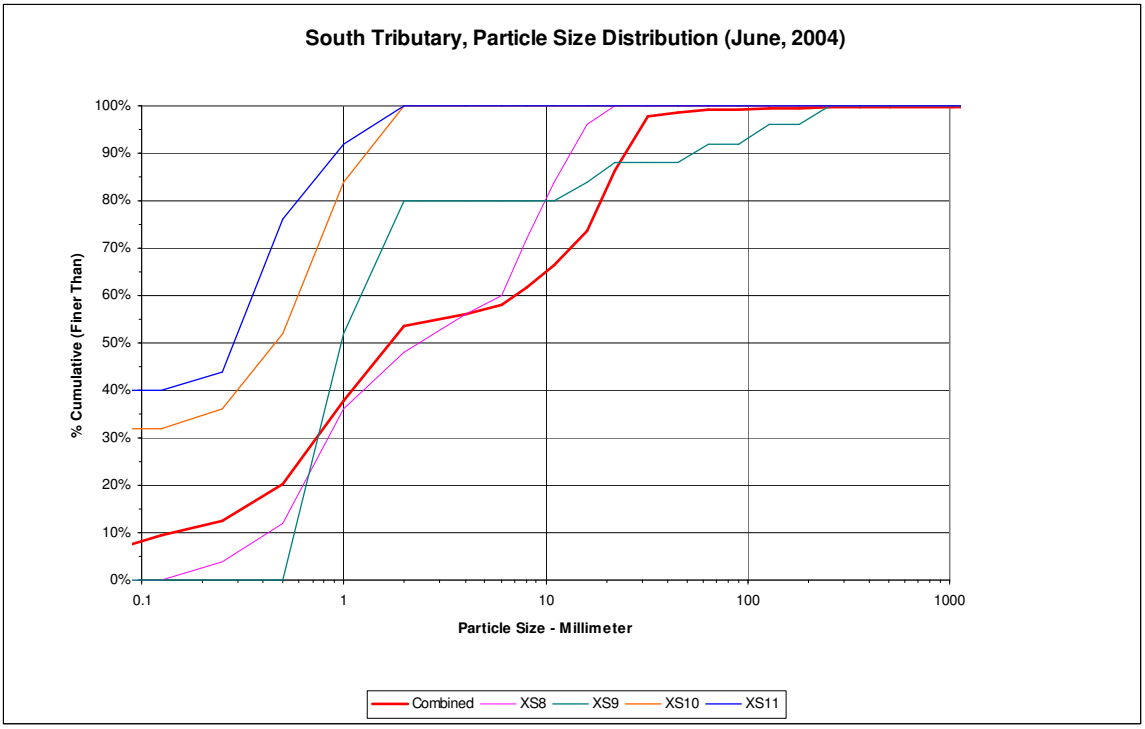
approximately 6.0 mm. The D_{50}s indicate that the Main, North, West, and Southwest Tributaries are gravel-bed streams and the South Tributary is a sand-bed stream.

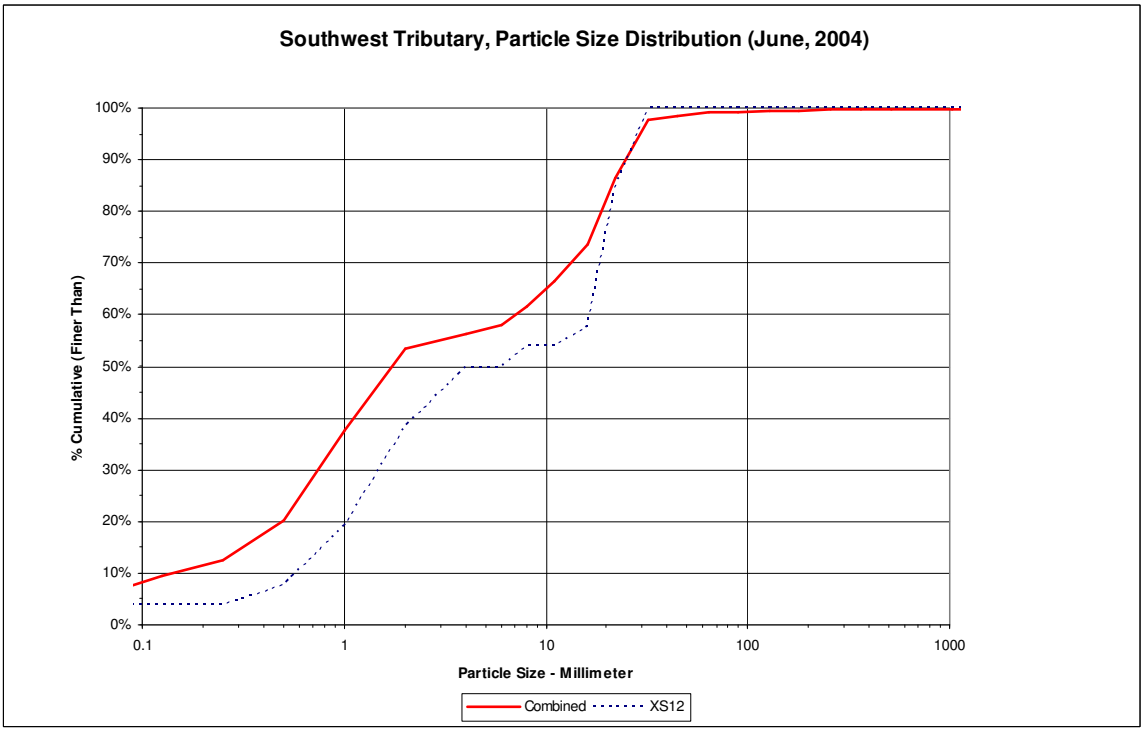
Five charts depicting the particle size distributions for the Main Tributary, North Tributary, West Tributary, South Tributary, and Southwest, respectively are presented below.




North Tributary, Particle Size Distribution (June, 2004)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Cumulative (Finer Than)
0.1
1
10
100
1000
Particle Size - Millimeter
Combined
XS1
XS2
XS3
XS4


West Tributary, Particle Size Distribution (June, 2004)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Cumulative (Finer Than)
0.1
1
10
100
1000
Particle Size - Millimeter
Combined
XS5
XS6
XS7





A longitudinal profile survey was conducted on the fours streams located at the Marks Creek Site (Appendix A). Bank stability was assessed during the cross section and longitudinal profile surveys. Several areas of deposition and active scouring were observed. Descriptions and evaluations of these areas are as follows:

Main Tributary to Marks Creek

- Station 13+00 through Station 13+10. A center bar was noted; however there was no indication of active erosion on the adjacent stream banks.
- Station 17+51 through Station 17+67. A transverse bar was observed in this area; however the adjacent streams banks appeared stable.

North Tributary

- Station 10+78 through Station 10+83. Active scouring along the right stream bank appears to have compromised the existing cross vane. This area will be re-assessed during the next monitoring period. No remedial actions are warranted at this time.
- Station 12+18 through Station 12+60. A center bar was observed; however the adjacent stream banks appeared stable with no active erosion.
- Station 13+66. A failing log vane has caused a back eddy to form and active erosion to take place along the adjacent stream banks. No remedial actions are required at this time; however this area will be re-assessed during the next monitoring period.
- Station 15+79 through Station 15+85. A center bar had developed in this area; however the adjacent stream banks appeared stable.
- Station 16+22 through Station 16+42. A center bar was noted; however there was no active erosion observed along the adjacent stream banks.

West Tributary

- Station 10+44 through Station 10+71. A center bar was observed in this area. The adjacent stream banks appeared stable with no active erosion.
- Station 11+15 through Station 11+35. A center bar has developed; however no active erosion was noted along the adjacent stream banks.

South Tributary

- Station 10+93 through 11+20. A center bar was noted in the stream channel; however no active erosion was noted along the adjacent stream banks.
- Station 11+48 through Station 11+54. An excessive amount of sediment has accumulated throughout this area. This area will be re-assessed during the next monitoring period. No remedial action is required at this time.
- Station 13+22 through 13+34. A center bar was observed throughout this area; however the adjacent stream banks appeared stable with no active erosion.
- Station 14+59 through 14+82. A center bar developed in this area; however no active erosion was observed along the adjacent stream banks.
- Station 14+20 through Station 19+70. The stream is heavily vegetated in this area. The channel has the possibility of aggrading throughout this area. A re-assessment of this area will take place during the next monitoring period. Remedial actions are not warranted.

Southwest Tributary

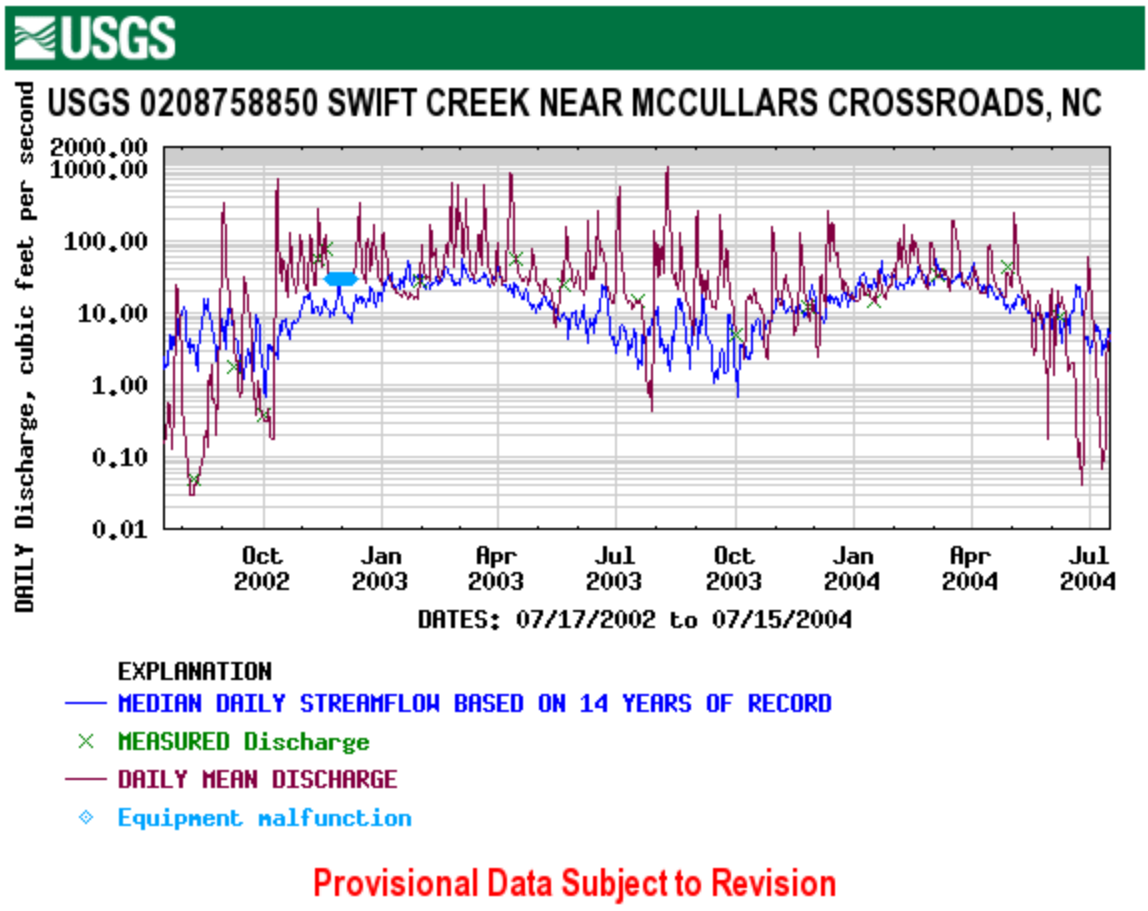
- Station 11+20. A transverse bar was beginning to form in this area. The adjacent stream banks were stable with no indication of active erosion.

- Station 11+54 through 11+64. The heavy deposition throughout this area has caused the formation of two channels. This area will be re-assed during the next monitoring period. No remedial action is required at this time.

2.3.2 Climatic Data

Monitoring requirements state that at least two bankfull events must be documented through the five-year monitoring period. No surface water gages exist on Marks Creek or its tributaries. A review of known U.S. Geological Survey (USGS) surface water gages identified one rural stream gage station within fifteen miles of the mitigation site. This gage station is identified as Swift Creek near McCullars Crossroads. The Swift Creek gage station has a drainage area of 35.8 square miles and is located approximately 15 miles southeast of the mitigation site near the confluence of Swift Creek and Lake Wheeler

The Swift Creek gage accurately reflects the hydrology and precipitation in the project area. It is situated in USGS Hydrologic Unit 03020201. Datum of the gage is 251.46 feet above sea level NGVD29. Based on the drainage area associated with the gage, the correlated bankfull discharge according to the NC Rural Piedmont Regional Curves (USACE, 2003) is between 770 and 1,760 cubic feet per second (cfs). A review of peak flows was conducted for the period between July 2002 and July 2004. According to the graph, there were two bankfull events occurring during this period, with both of the events happening in 2003. The USGS graph depicting these peak flows is presented below.



2.4 Conclusions

The Main Tributary to Marks Creek, the North Tributary, the West Tributary, the Southwest Tributary, and the South Tributary are in the process of expunging the excess sediment from the construction of the Knightdale Bypass. Areas of deposition and scour exist along the reaches. These areas will be reassessed in 2005.

Based on information obtained from the USGS, the Marks Creek Site has met the required monitoring protocols for hydrology as it relates to bankfull events. No supplemental work is proposed at this time.

NCDOT will continue stream monitoring at the site for 2005.

3.0 REFERENCES

North Carolina Department of Transportation (NCDOT), 2001. Mitigation Plan for the Marks Creek Mitigation Site, Main Tributary to Marks Creek and three tributaries, Phase II, Wake County.

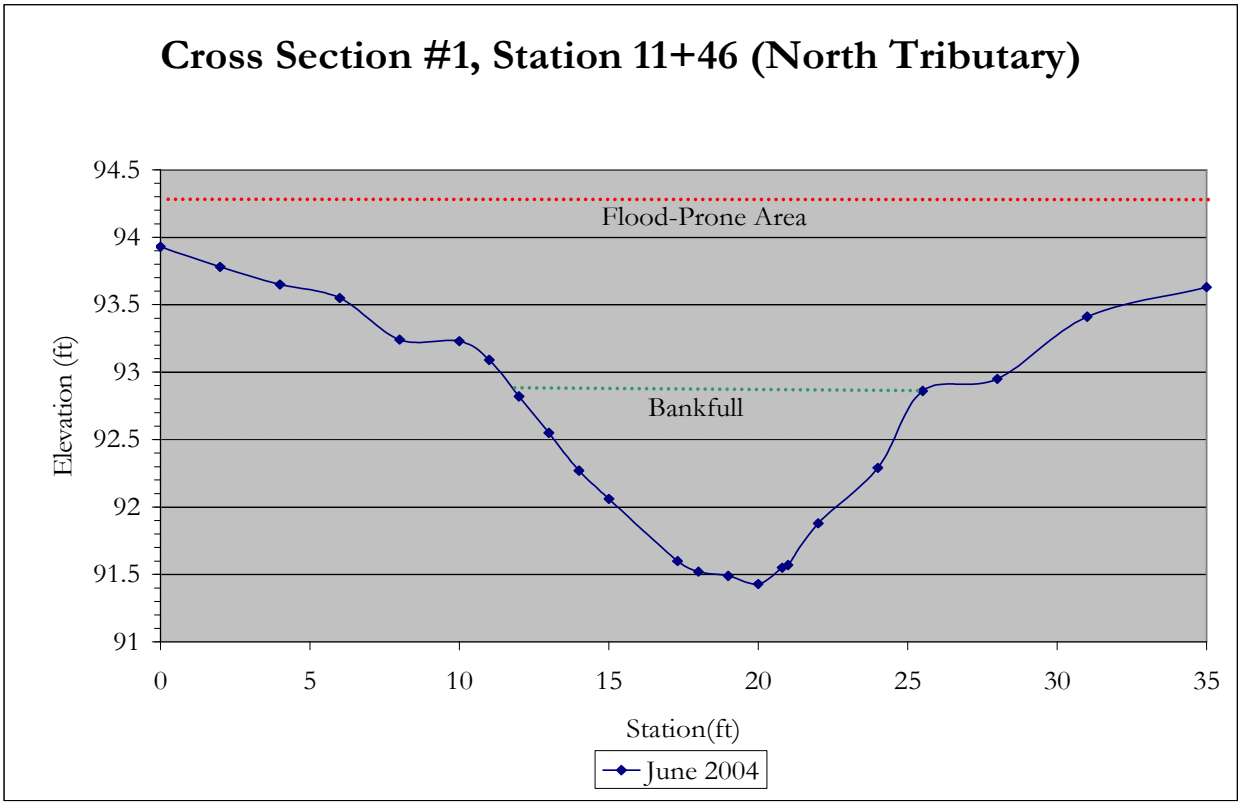
Rosgen, D.L, 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

US Army Corps of Engineers (USACE), 2003. Stream Mitigation Guidelines. Prepared with cooperation from the US Environmental Protection Agency, NC Wildlife Resources Commission, and the NC Division of Water Quality.

US Geological Survey (USGS), 2004. Real-time Data for USGS 0208758850 Swift Creek near McCullars Crossroads, NC. http://waterdata.usgs.gov/nc/nwis.

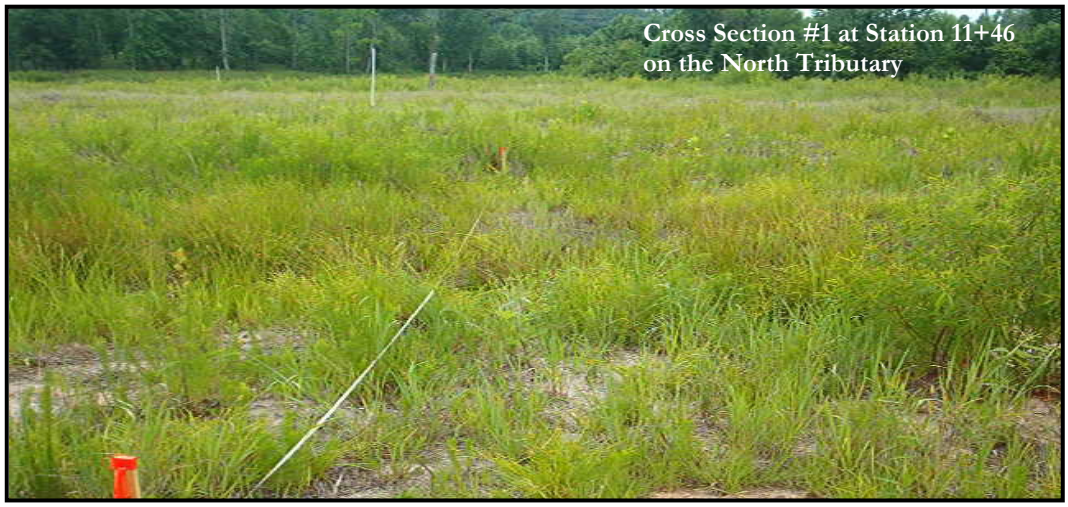
APPENDIX A

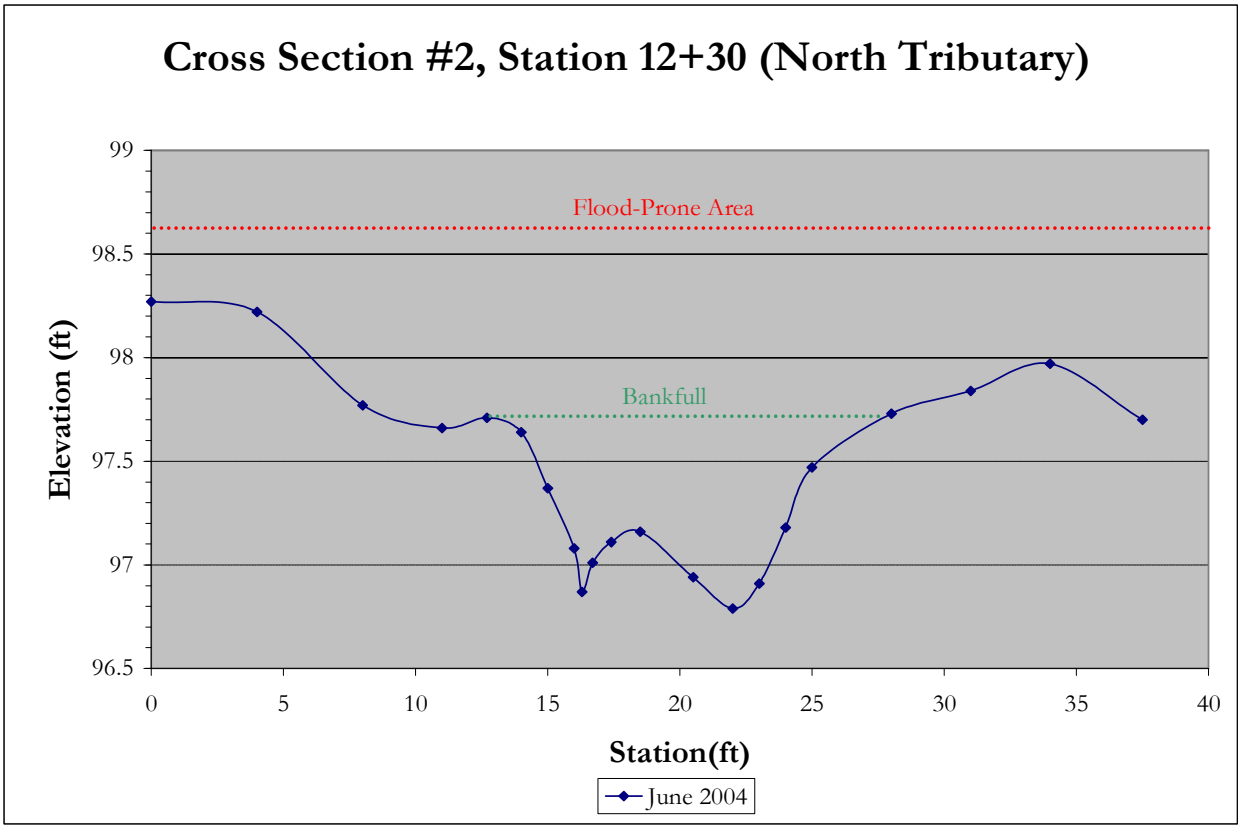
CROSS SECTIONS AND LONGITUDINAL PROFILES



Cross-Section #1 (Riffle) Abbreviated Morphological Summary

	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	12.2				
Maximum Bankfull Depth (ft)	1.4				
Width of the Floodprone Area (ft)	300				
Bankfull Mean Depth (ft)	0.9				
Width/Depth Ratio	15.8				
Entrenchment Ratio	22.1				
Bankfull Width (ft)	13.6				

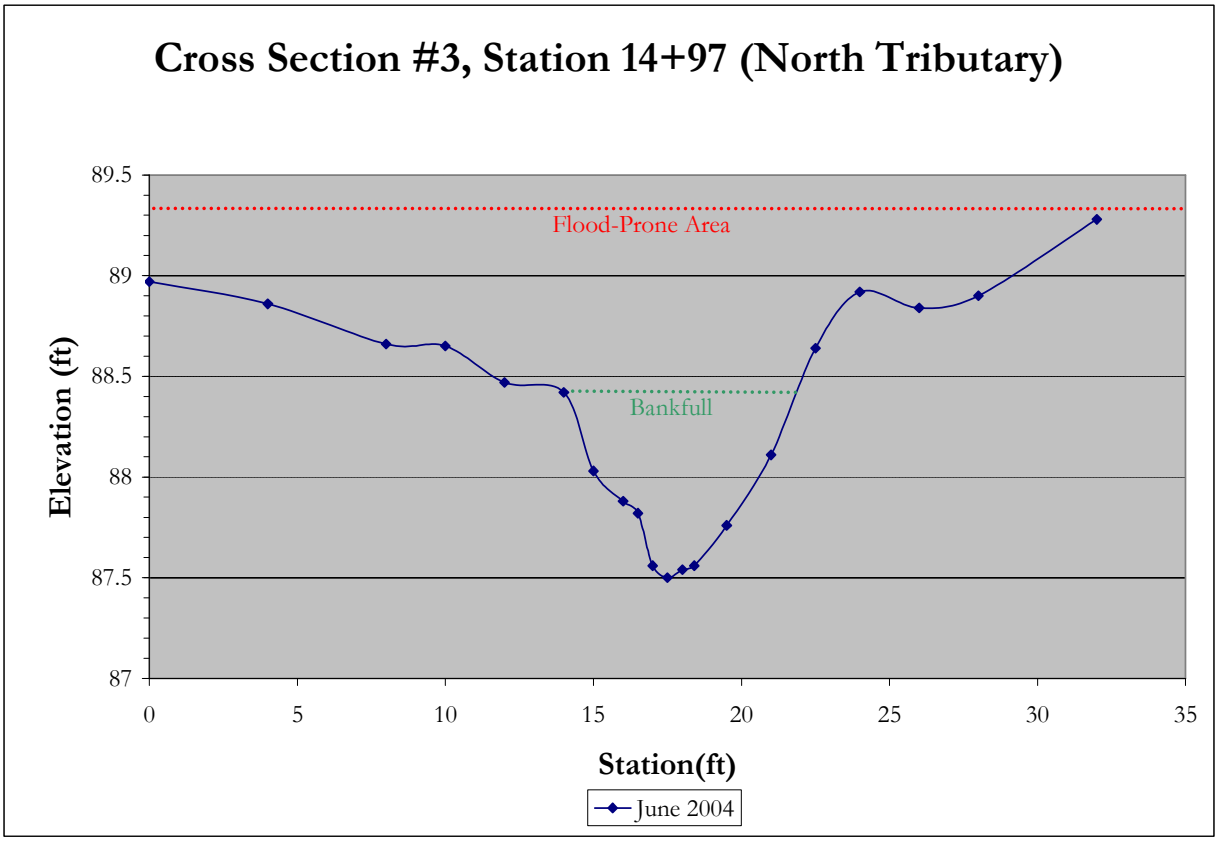




Cross-Section #2 (Riffle) Abbreviated Morphological Summary

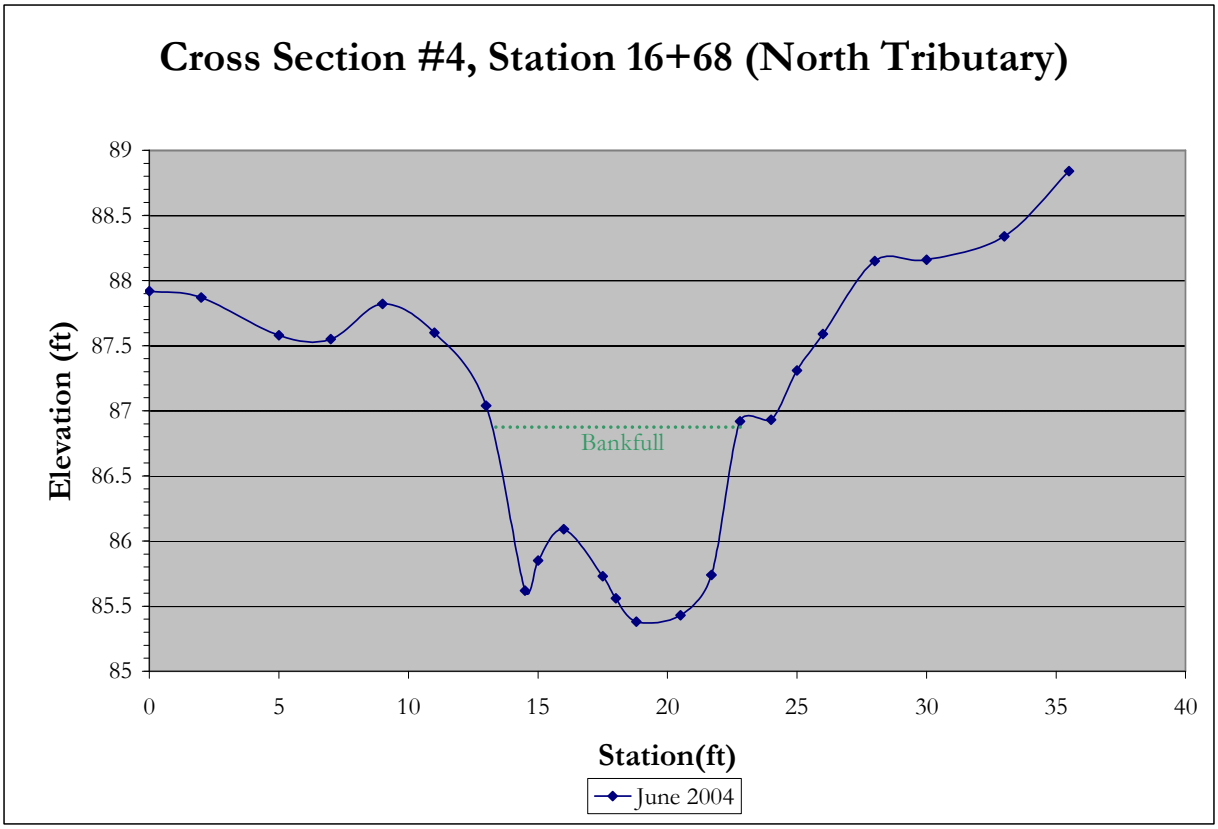
	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	7.6				
Maximum Bankfull Depth (ft)	0.9				
Width of the Floodprone Area (ft)	300				
Bankfull Mean Depth (ft)	0.5				
Width/Depth Ratio	30.4				
Entrenchment Ratio	19.7				
Bankfull Width (ft)	15.2				

Cross Section #2 at Station 12+30 on the North Tributary



Cross-Section #3 (Riffle) Abbreviated Morphological Summary

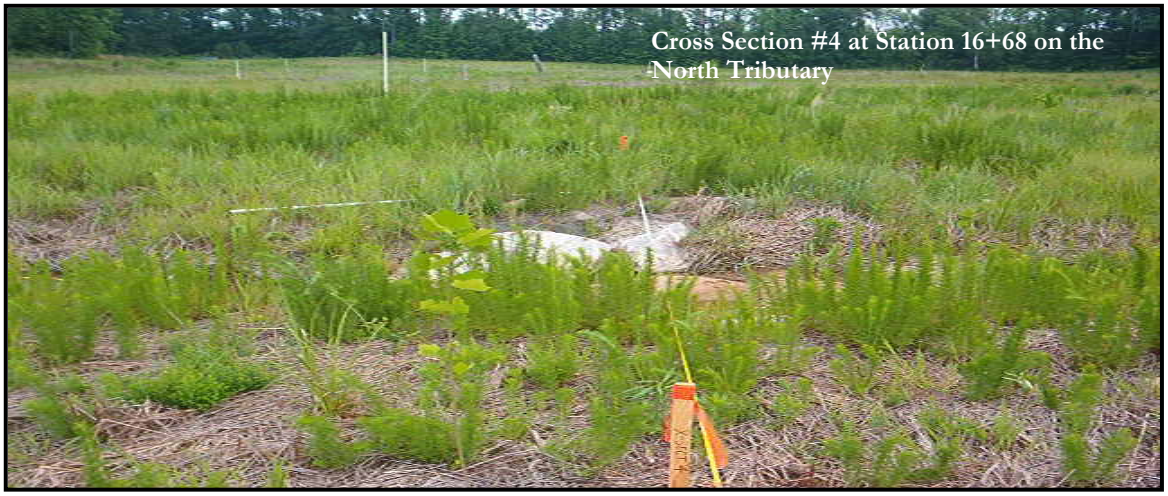
	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	4.0				
Maximum Bankfull Depth (ft)	0.9				
Width of the Floodprone Area (ft)	400				
Bankfull Mean Depth (ft)	0.5				
Width/Depth Ratio	15.8				
Entrenchment Ratio	50.6				
Bankfull Width (ft)	7.9				

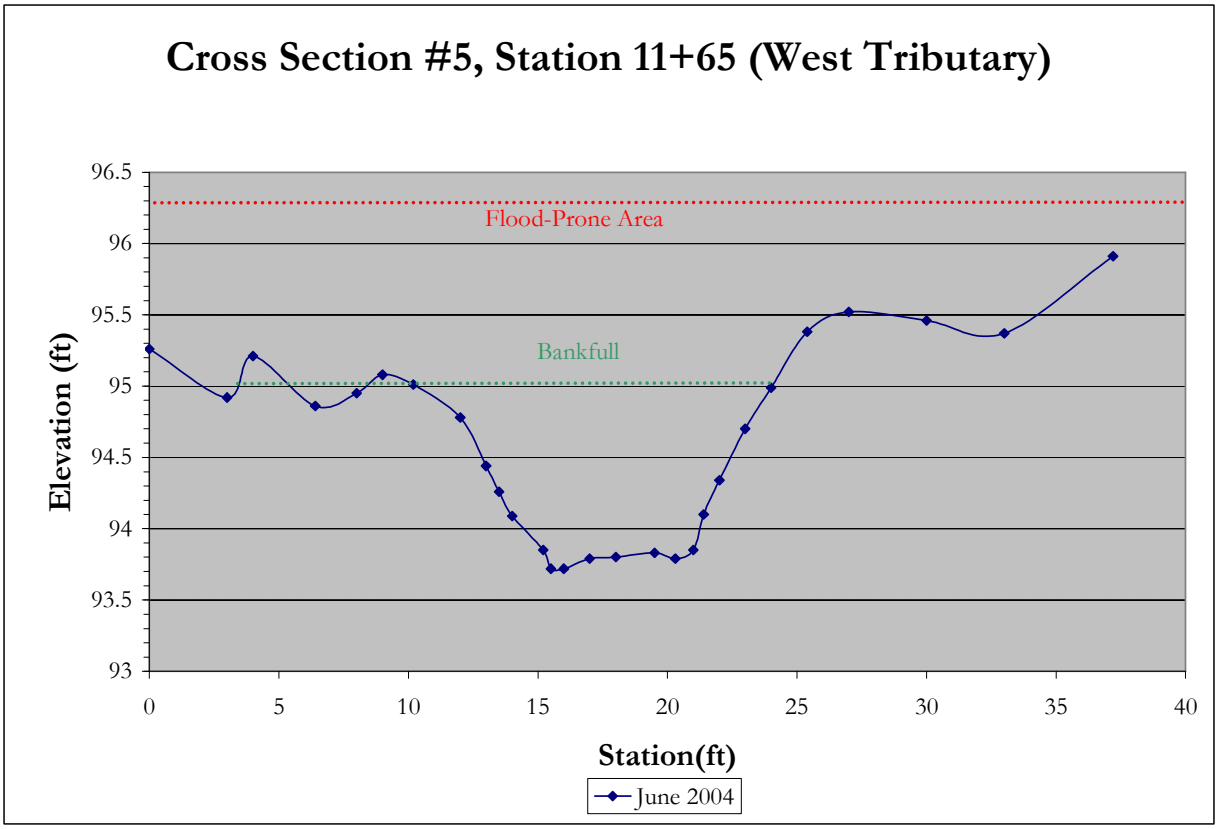


Cross-Section #4 (Pool) Abbreviated Morphological Summary*

	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	**10.6**				
Maximum Bankfull Depth (ft)	**1.5**				
Bankfull Mean Depth (ft)	**1.1**				
Bankfull Width (ft)	**9.6**				

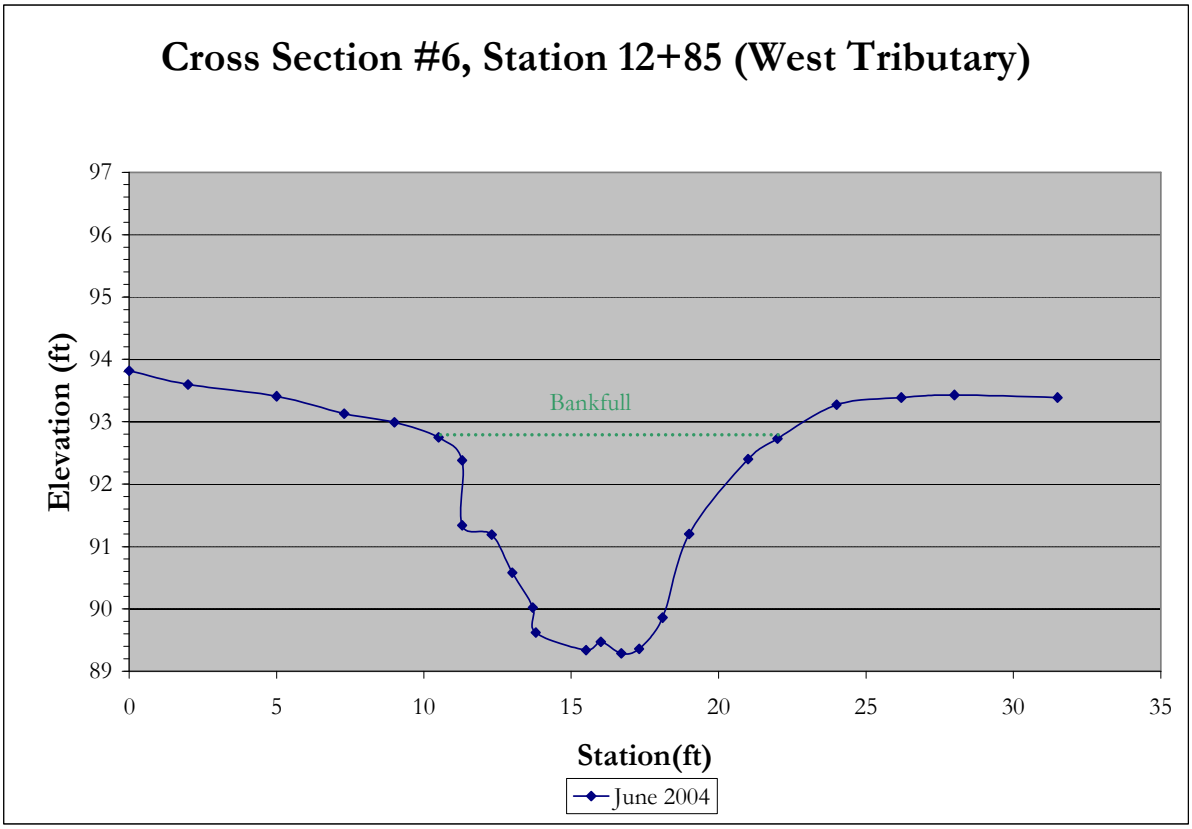
*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.





Cross-Section #5 (Riffle) Abbreviated Morphological Summary

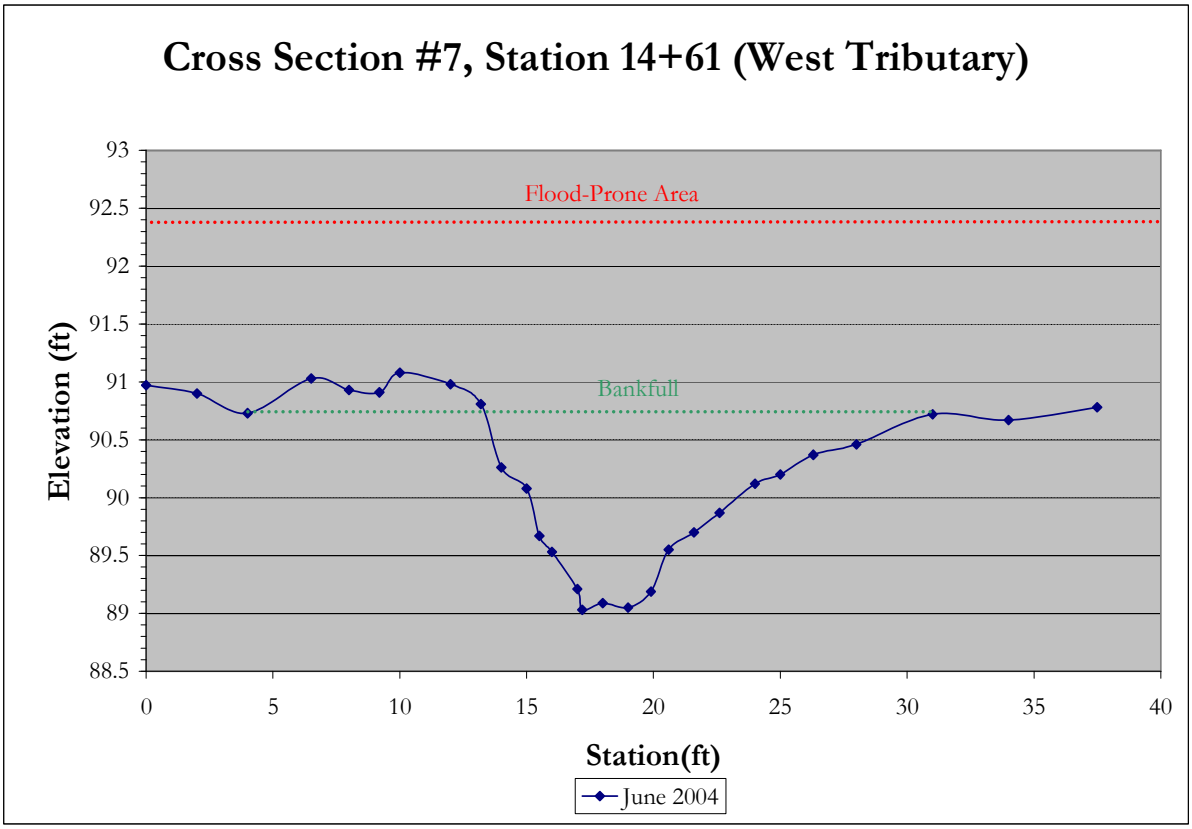
	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	11.3				
Maximum Bankfull Depth (ft)	1.3				
Width of the Floodprone Area (ft)	375				
Bankfull Mean Depth (ft)	0.8				
Width/Depth Ratio	17.6				
Entrenchment Ratio	26.6				
Bankfull Width (ft)	14.1				



Cross-Section #6 (Pool) Abbreviated Morphological Summary*

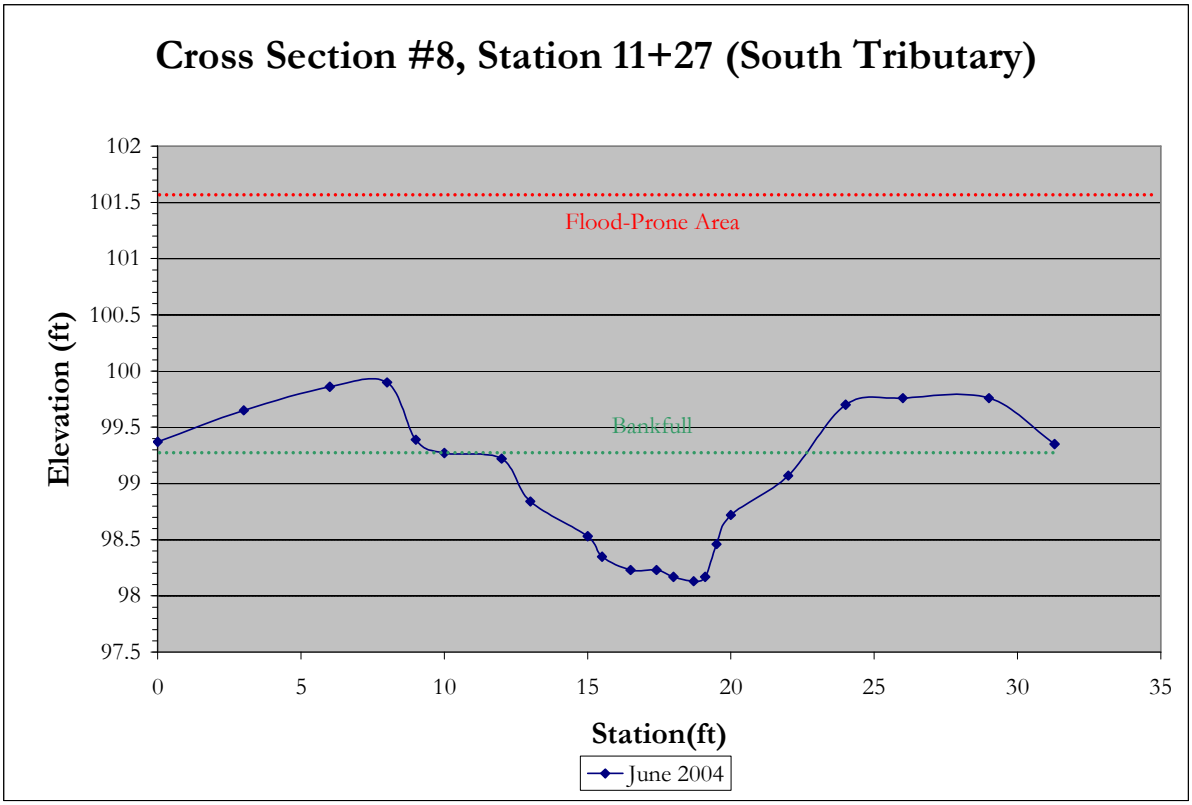
	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	**23.0**				
Maximum Bankfull Depth (ft)	**3.4**				
Bankfull Mean Depth (ft)	**2.0**				
Bankfull Width (ft)	**11.5**				

*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.



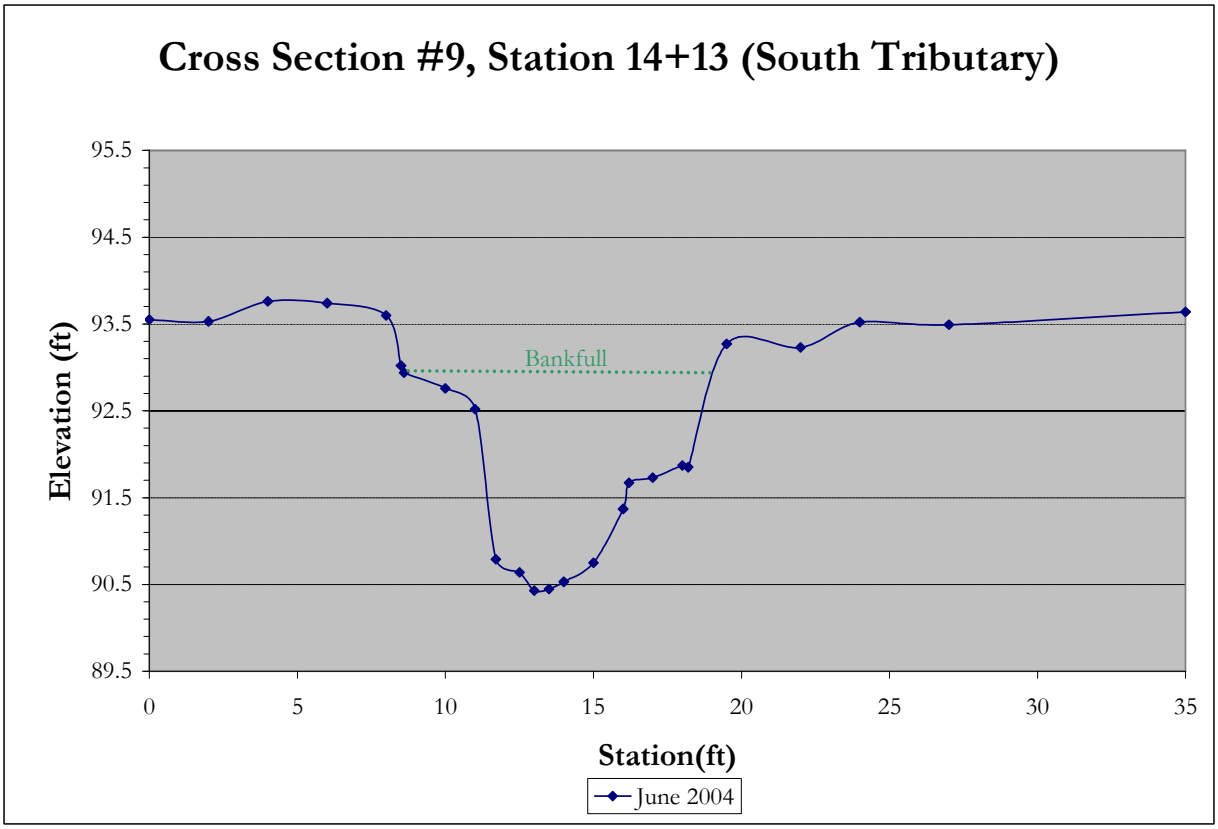
Cross-Section #7 (Riffle) Abbreviated Morphological Summary

	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	13.4				
Maximum Bankfull Depth (ft)	1.7				
Width of the Floodprone Area (ft)	450				
Bankfull Mean Depth (ft)	0.6				
Width/Depth Ratio	37.2				
Entrenchment Ratio	20.2				
Bankfull Width (ft)	22.3				



Cross-Section #8 (Riffle) Abbreviated Morphological Summary

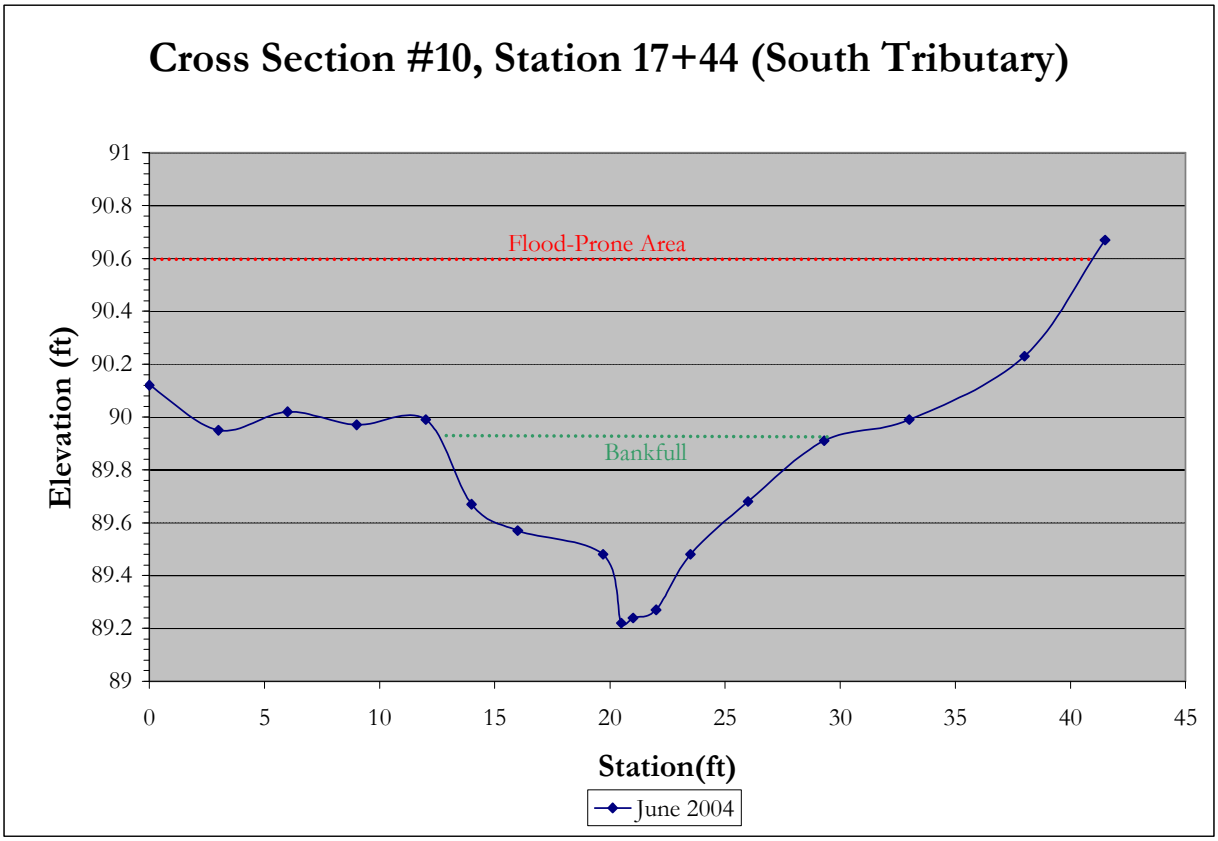
	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	6.3				
Maximum Bankfull Depth (ft)	1.1				
Width of the Floodprone Area (ft)	75.0				
Bankfull Mean Depth (ft)	0.6				
Width/Depth Ratio	17.5				
Entrenchment Ratio	7.1				
Bankfull Width (ft)	10.5				



Cross-Section #9 (Pool) Abbreviated Morphological Summary*

	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	**8.5**				
Maximum Bankfull Depth (ft)	**2.5**				
Bankfull Mean Depth (ft)	**0.8**				
Bankfull Width (ft)	**10.6**				

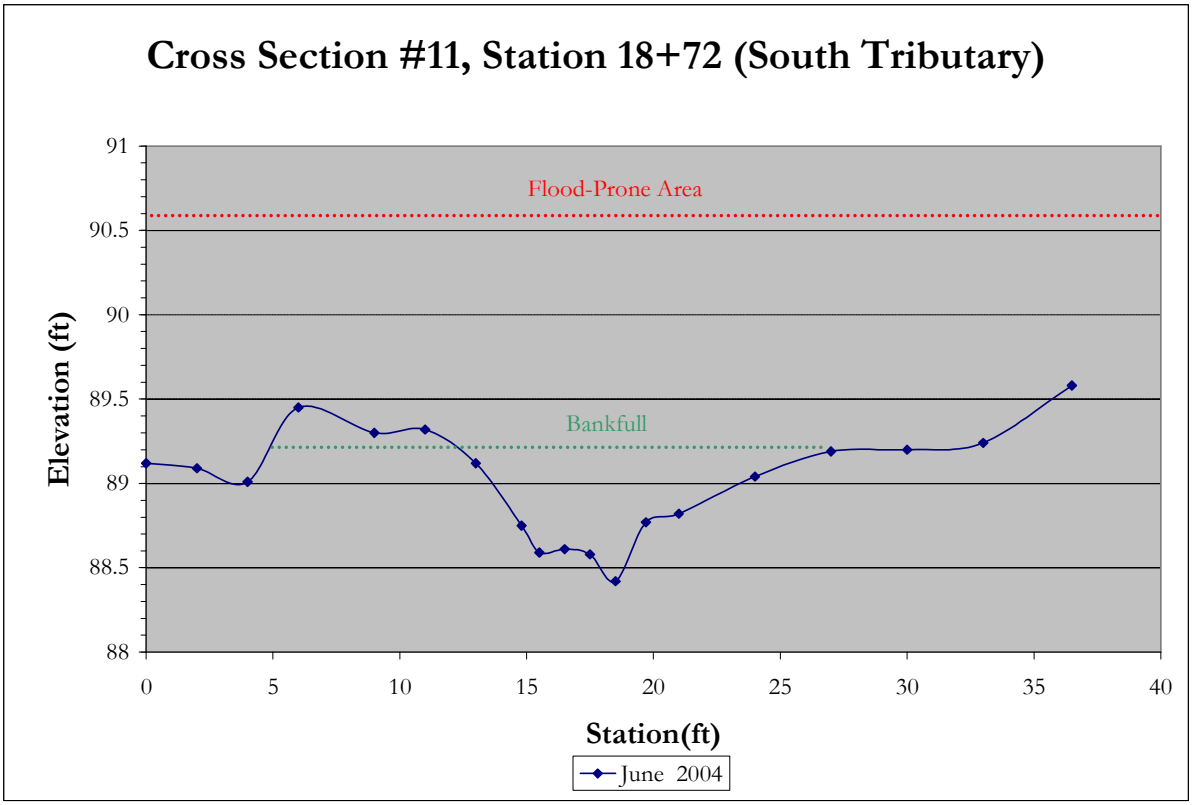
*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.



Cross-Section #10 (Run) Abbreviated Morphological Summary

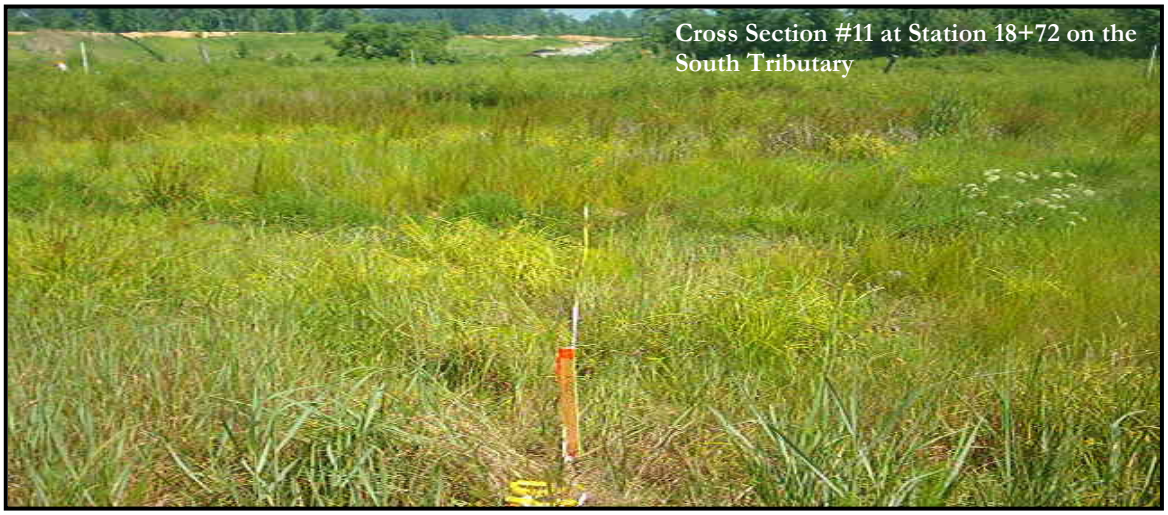
	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	5.0				
Maximum Bankfull Depth (ft)	0.7				
Width of the Floodprone Area (ft)	450				
Bankfull Mean Depth (ft)	0.3				
Width/Depth Ratio	56.0				
Entrenchment Ratio	26.8				
Bankfull Width (ft)	16.8				

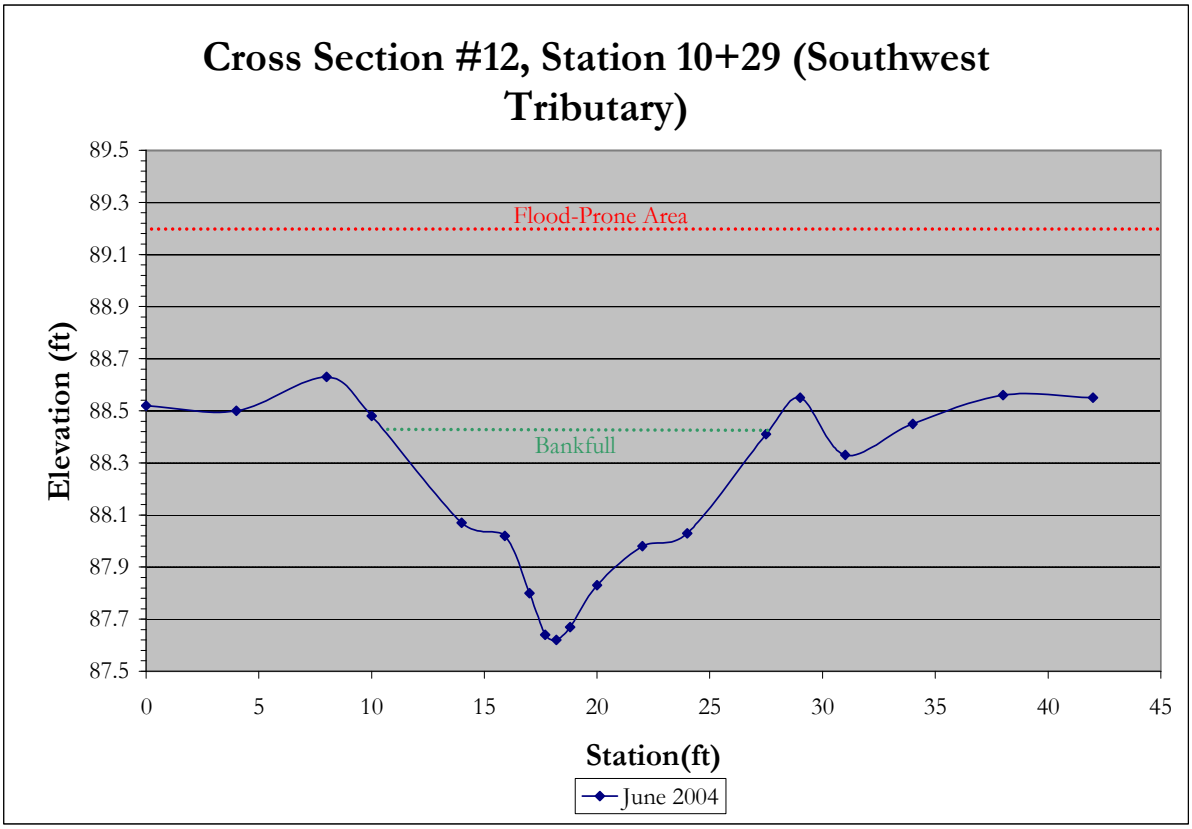
Cross Section #10 at Station 17+44 on the South Tributary



Cross-Section #11 (Riffle) Abbreviated Morphological Summary

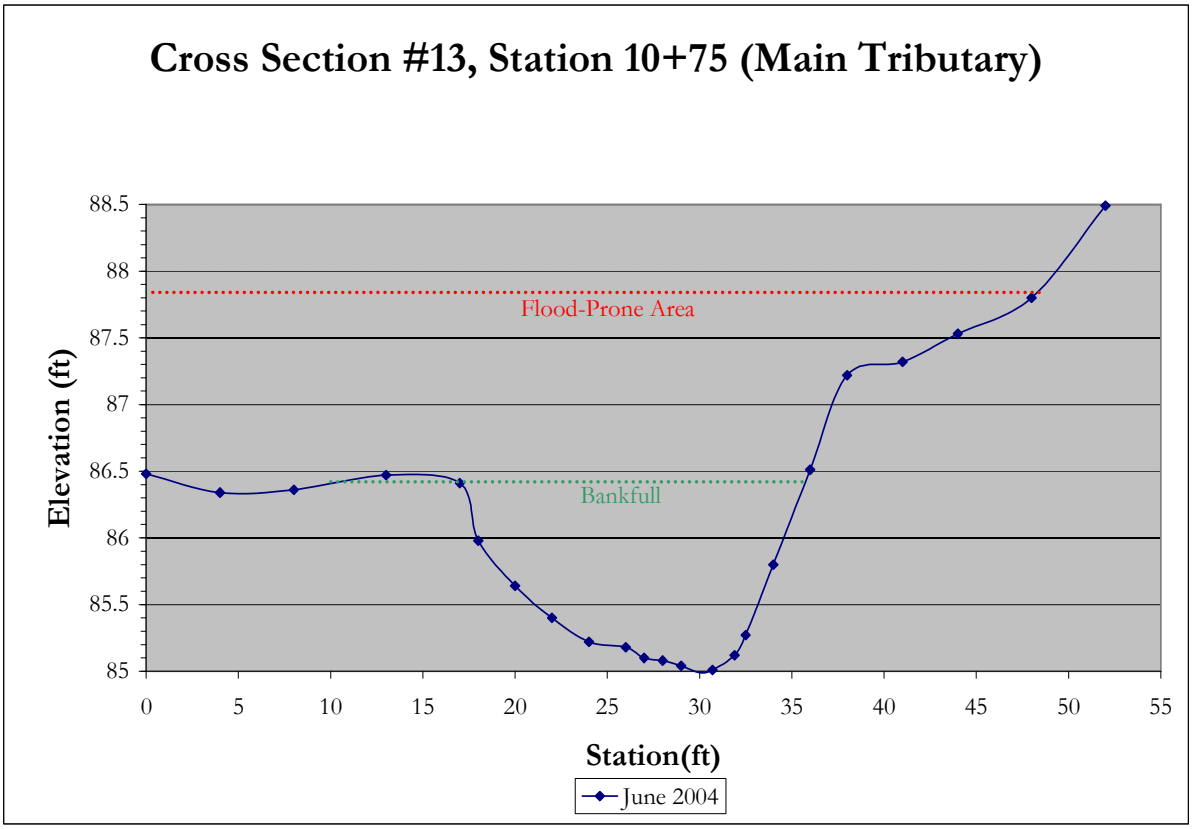
	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	4.4				
Maximum Bankfull Depth (ft)	0.8				
Width of the Floodprone Area (ft)	150				
Bankfull Mean Depth (ft)	0.3				
Width/Depth Ratio	49.0				
Entrenchment Ratio	10.2				
Bankfull Width (ft)	14.7				





Cross-Section #12 (Riffle) Abbreviated Morphological Summary

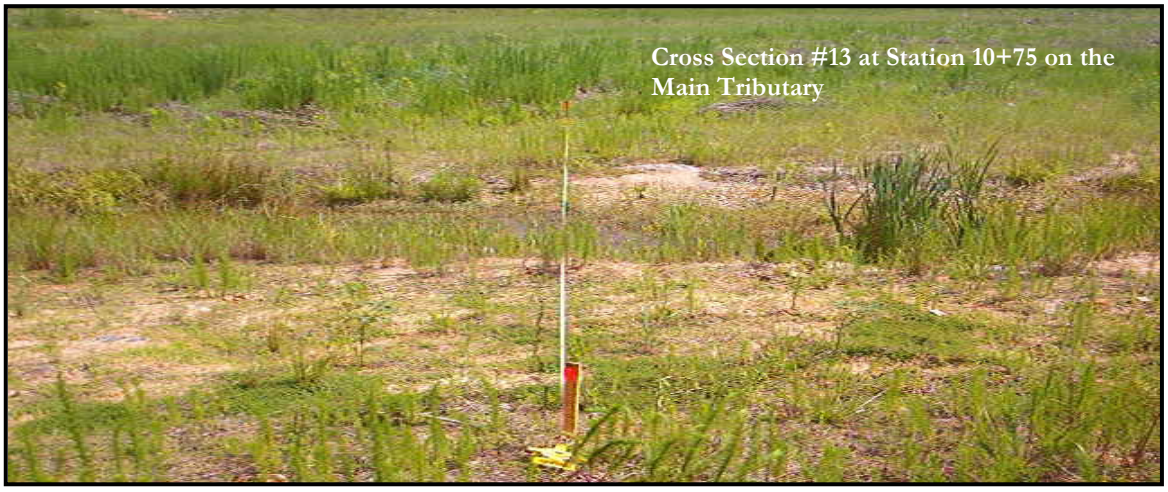
	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	4.8				
Maximum Bankfull Depth (ft)	0.7				
Width of the Floodprone Area (ft)	375				
Bankfull Mean Depth (ft)	0.3				
Width/Depth Ratio	53.0				
Entrenchment Ratio	23.6				
Bankfull Width (ft)	15.9				

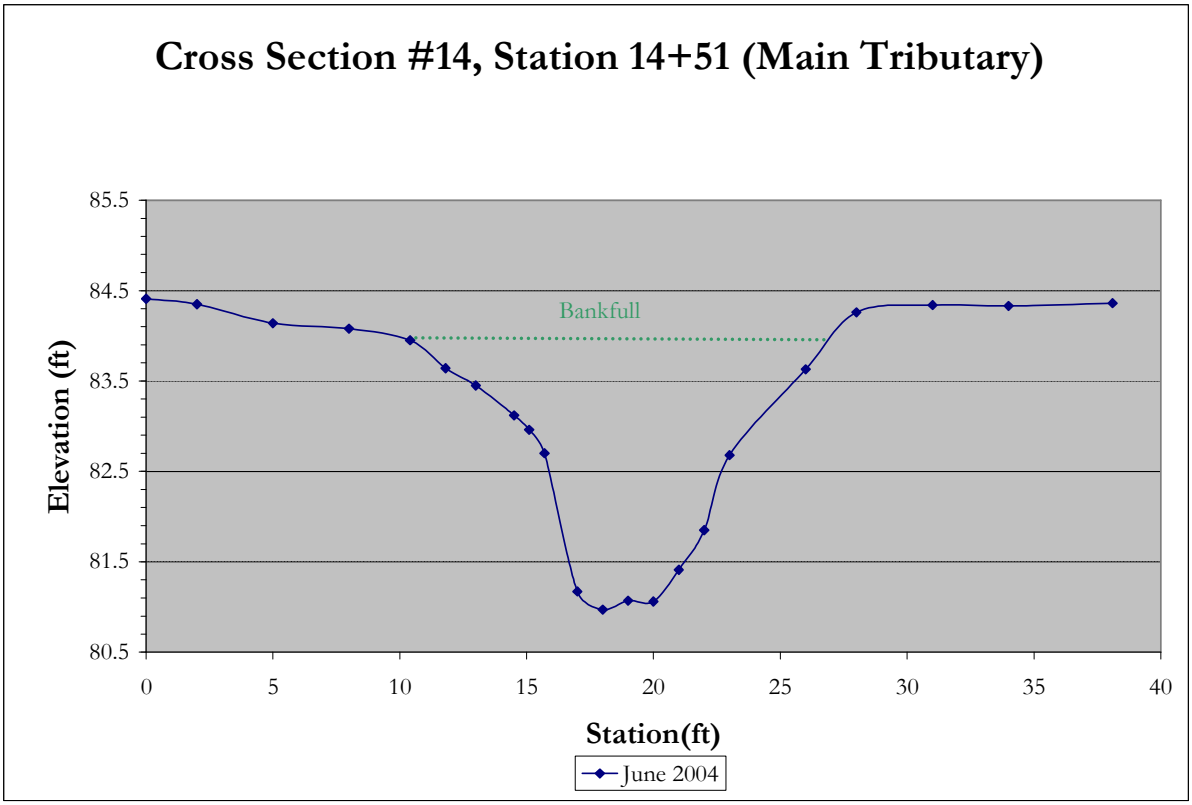


Cross-Section #13 (Run) Abbreviated Morphological Summary*

	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft²)	**18.7**				
Maximum Bankfull Depth (ft)	**1.4**				
Bankfull Mean Depth (ft)	**1.0**				
Bankfull Width (ft)	**18.7**				

*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.

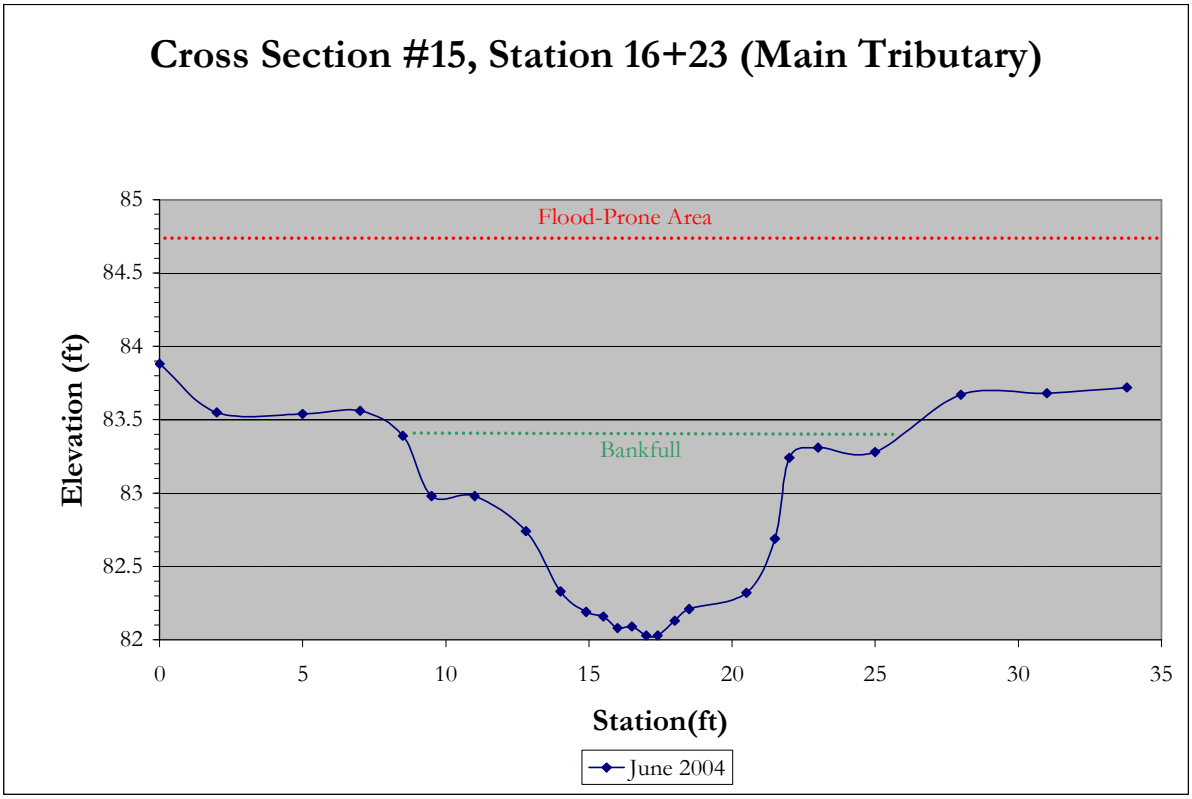




Cross-Section #14 (Pool) Abbreviated Morphological Summary*

	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	**23.2**				
Maximum Bankfull Depth (ft)	**3**				
Bankfull Mean Depth (ft)	**1.4**				
Bankfull Width (ft)	**16.6**				

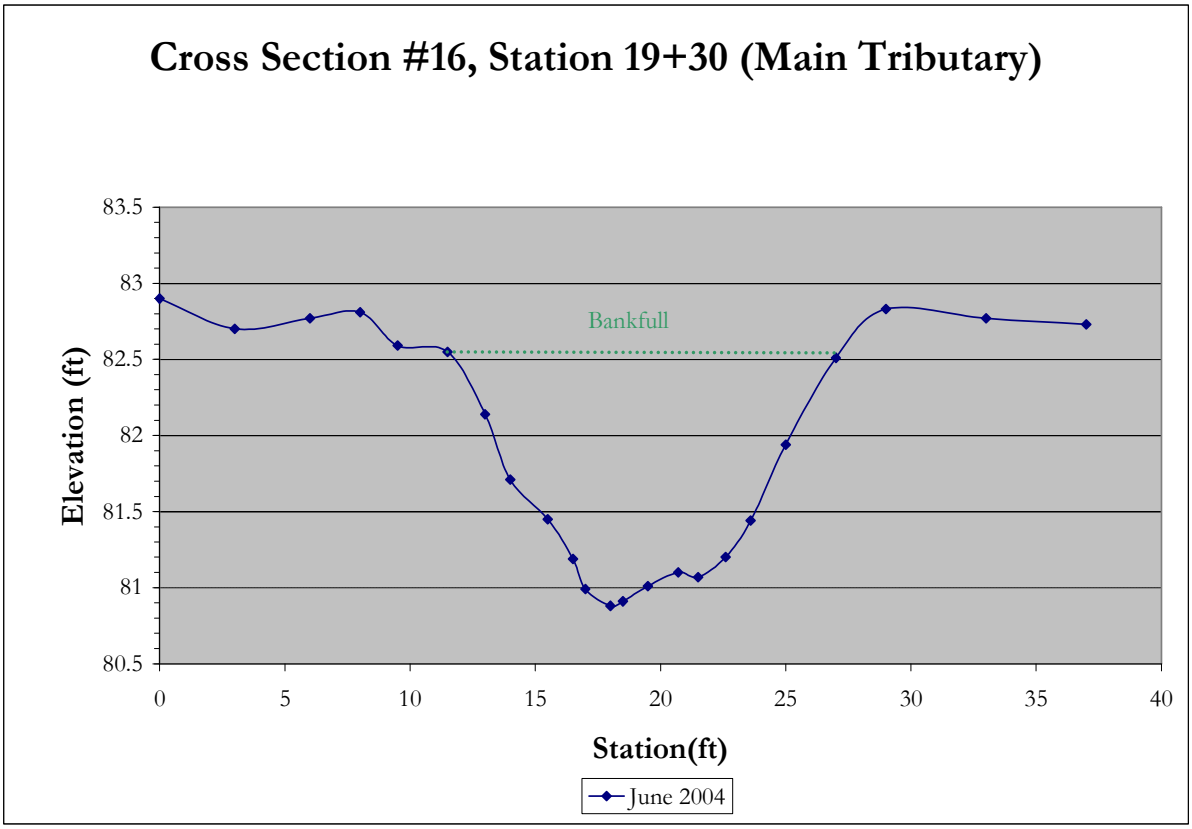
*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide, or run features.



Cross-Section #15 (Riffle) Abbreviated Morphological Summary

	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	12.1				
Maximum Bankfull Depth (ft)	1.4				
Bank Height (ft)	1.5				
Width of Floodprone Area (ft)	600				
Bankfull Mean Depth (ft)	0.7				
Width/Depth Ratio	24.7				
Entrenchment Ratio	34.7				
Bankfull Width (ft)	17.3				

Cross Section #15 at Station 16+23 on the Main Tributary

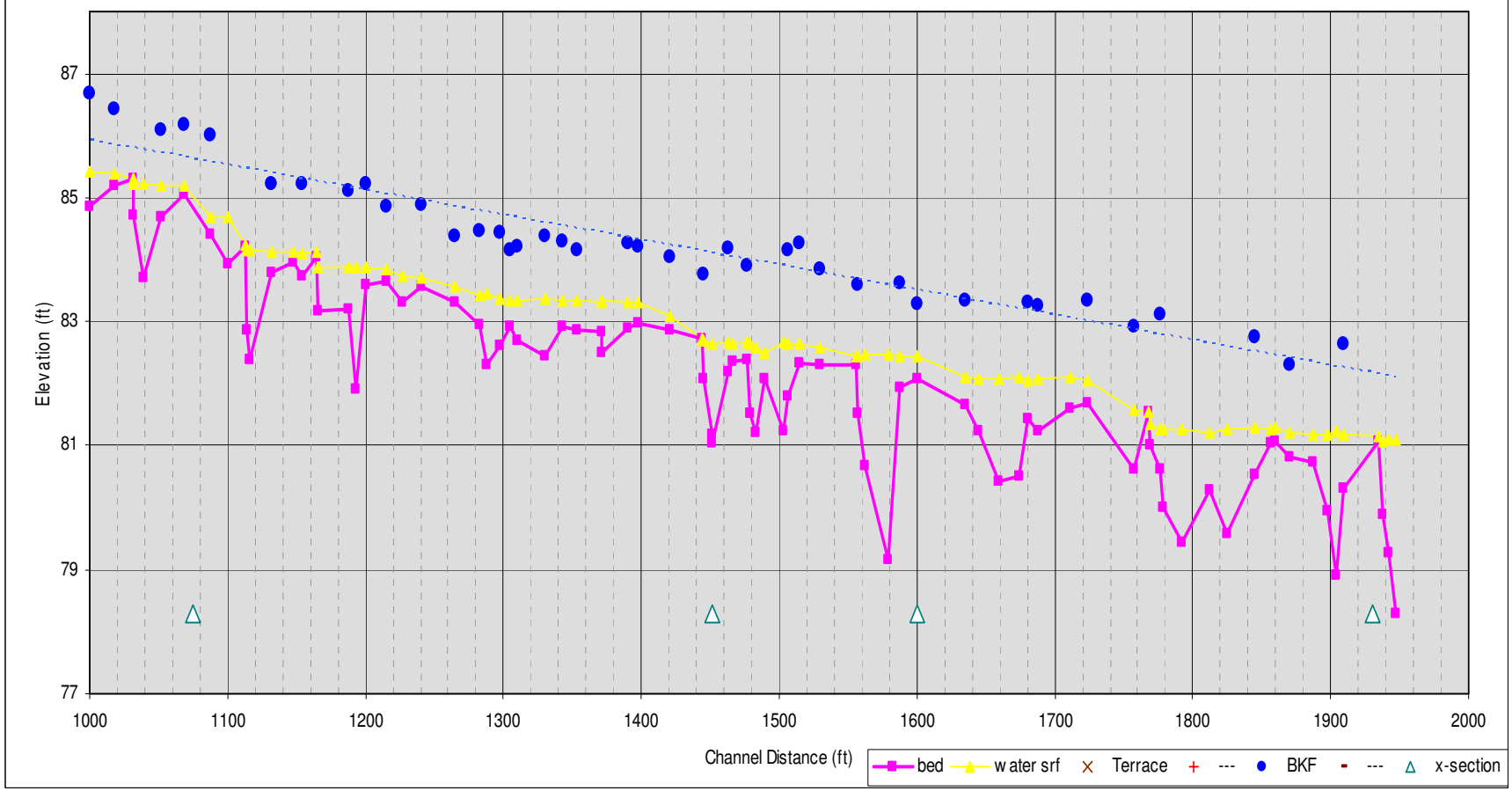


Cross-Section #16 (Glide) Abbreviated Morphological Summary*

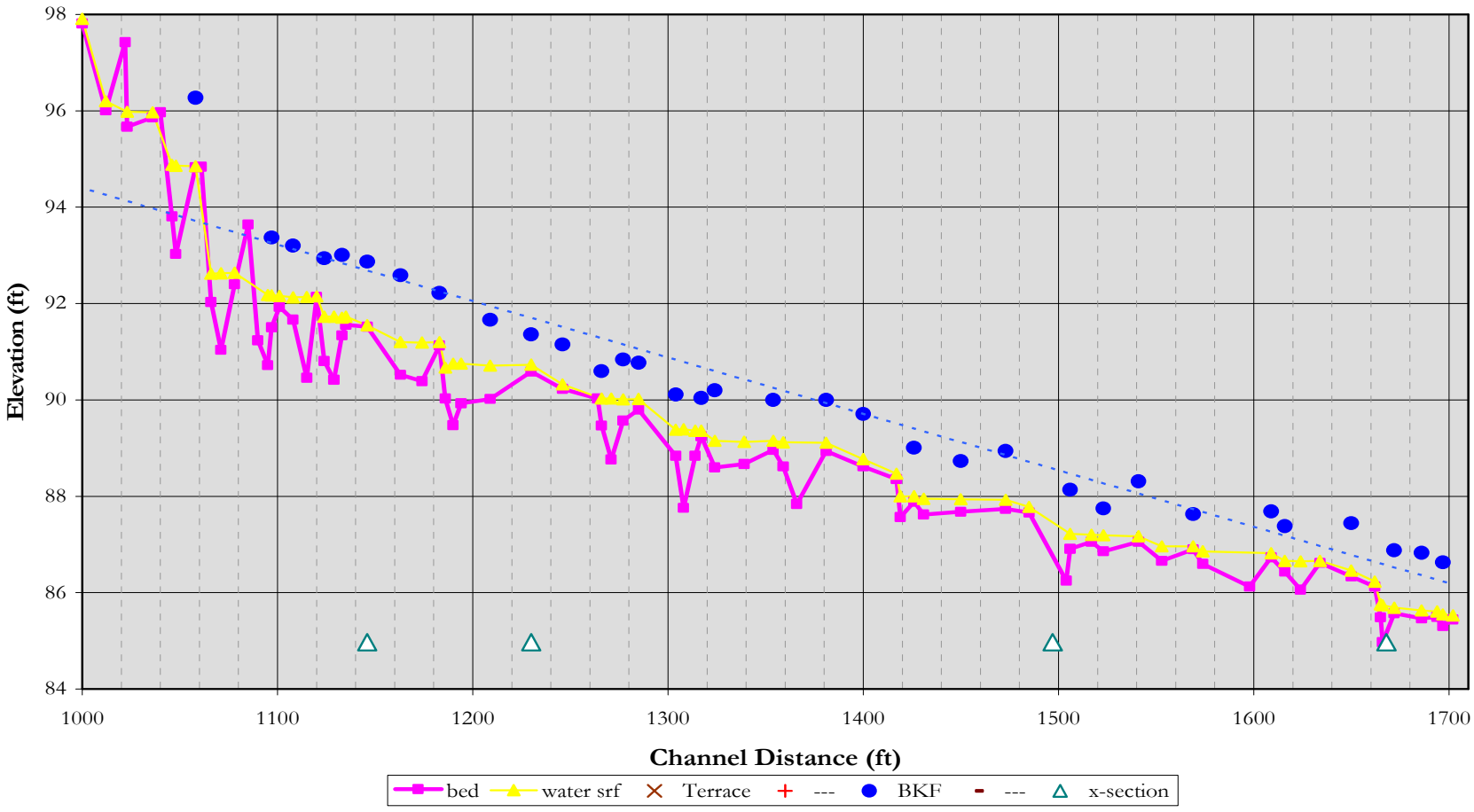
	2004	2005	2006	2007	2008
Bankfull Cross Sectional Area (ft^2)	**15.8**				
Maximum Bankfull Depth (ft)	**1.7**				
Bankfull Mean Depth (ft)	**1**				
Bankfull Width (ft)	**15.8**				

*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.

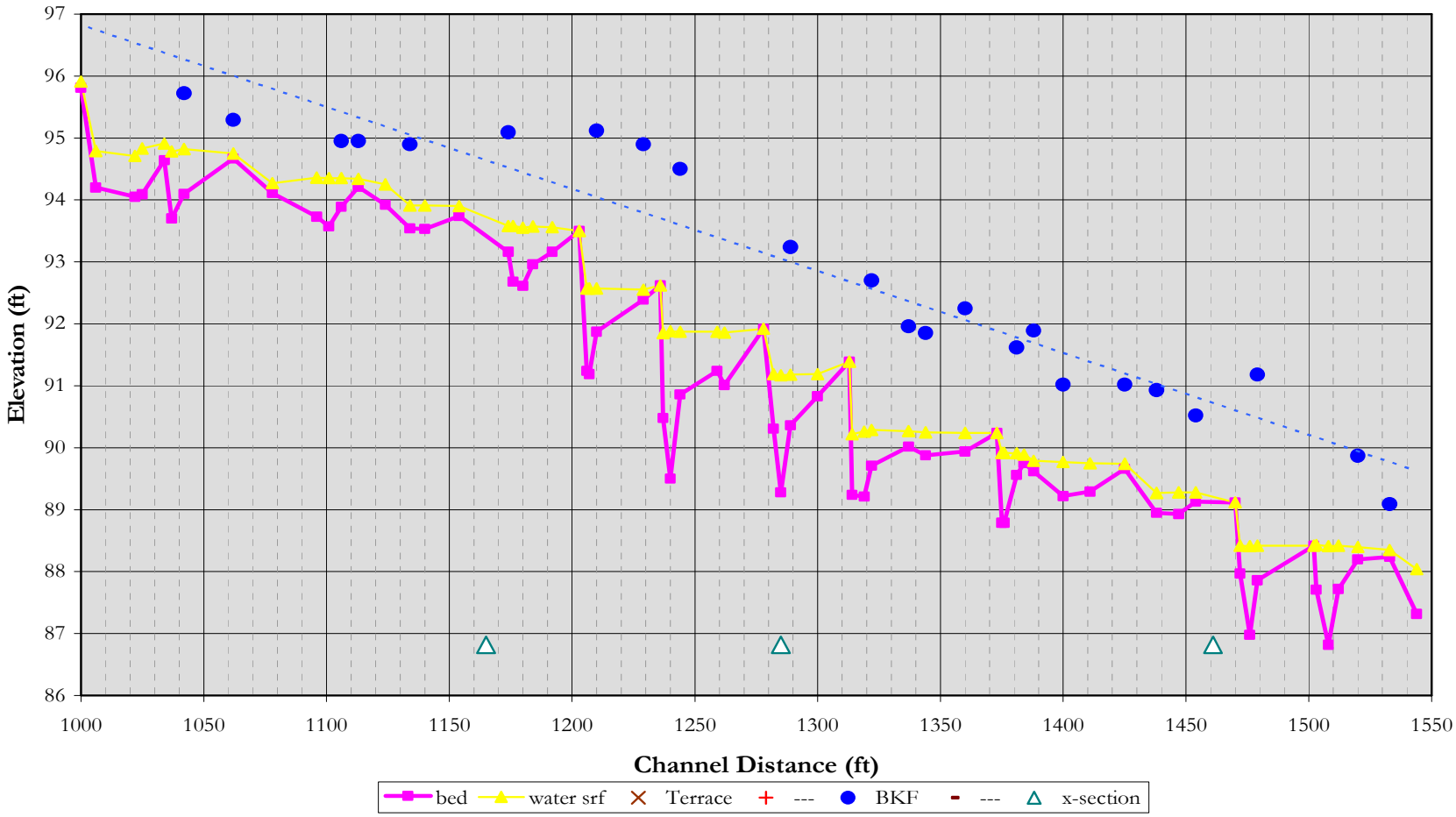
Longitudinal Profile of the Main Tributary, June 2004



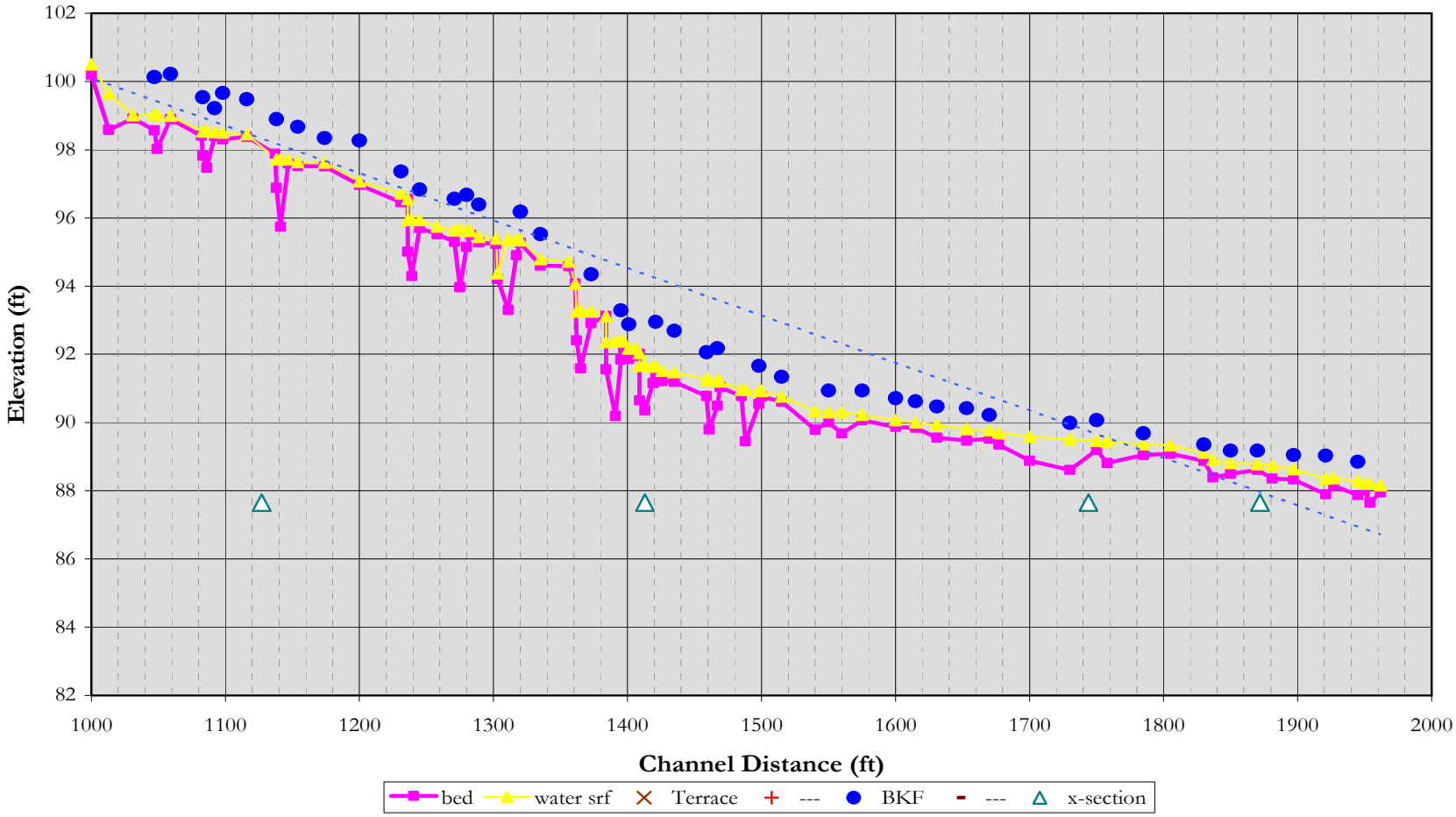
Longitudinal Profile of the North Tributary, June 2004



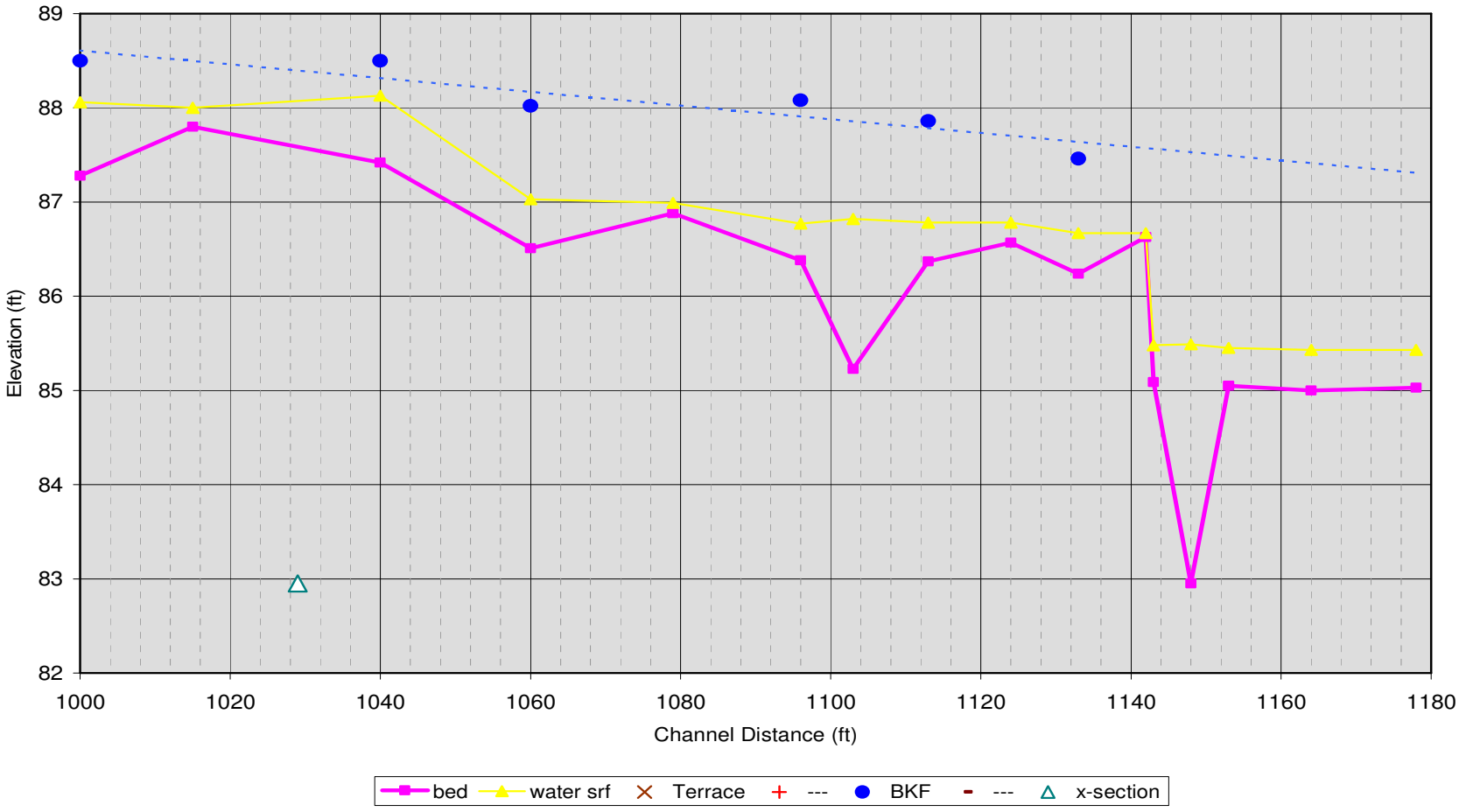
Longitudinal Profile of the West Tributary, June 2004



Longitudinal Profile of the South Tributary, June 2004



Longitudinal Profile of the Southwest Tributary, June 2004



APPENDIX B

SITE PHOTOGRAPHS

Marks Creek Site Photo Points

Marks Creek Site Photo Points Continued…


Photo Point #5
facing northwest


Photo Point #5
facing southwest

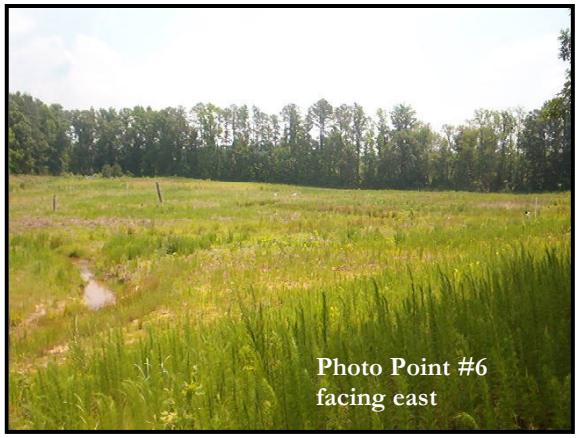


Photo Point #6
facing east


Photo Point #6
facing north


Photo Point #6
facing west

Main Tributary to Marks Creek

Station 14+66 to 14+76 - Center bar forming

Station 17+69 to 17+75 - Depositional area below cross vane

Station 18+92 – Cross vane below grade

Station 19+17 to 19+33 – Transverse bar forming

North Tributary

Station 10+78 to 10+83 – Erosion along right arm of cross vane

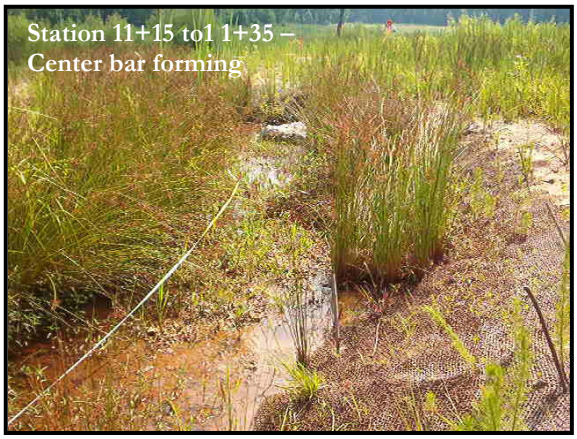
Station 12+18 to 12+60 – Center bar forming

Station 13+66 – Failing log vane is causing back eddy erosion

Station 15+79 to 15+85 – Center bar forming

Station 16+22 to 16+42 – Center bar forming

West Tributary



South Tributary

Southwest Tributary